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A SHORT RÉSUMÉ OF THE RESEARCHES INTO THE EUROPEAN RACES OF HERRINGS AND THE METHOD OF INVESTIGATION.

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A SHORT RÉSUMÉ

OF THE

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METHOD OF INVESTIGATION.

By H. Charles Williamson, M.A., D.Sc., F.R.S.E.,
Marine Laboratory, Aberdeen.

At the present time the races of herrings are about to be investigated by the International Committee for the Exploration of the North Sea.

It may therefore be of advantage to review the work done on this subject by Heincke and Matthews.

I propose to give in the form of extracts from their works, the opinions of these investigators regarding the problem, the methods by which they tested the theory, and the results. Heincke dealt with the herrings of the North Sea, Baltic Sea, and White Sea. Matthews' work is confined to Scottish herrings.

Professor Heincke * has divided the herrings of Europe into several races.

He defines a race as follows :—

" A race clearly constitutes such shoals as deposit their eggs at the same time of year on spawning-beds situated more or less near to one another, and having bottom and water of a similar nature. The shoals, after spawning, disappear, and return the following year at the same time and in a similar ripe condition " (p. xi).

Heincke calls " a number of individuals which live under similar outer conditions, and which are in direct sexual intermixture and thereby of blood relationship, a race (family, stock) " (p. xliv).

" The races of herring differ from one another in very many particulars, and generally in these characters in which the species of the genus *Clupea* differ from one another " (p. xxii).

" The differences between the races are small ; as a rule not so large as we find in the different species of *Clupea* ; but they are no less sharply and characteristically impressed. Each individual

* Heincke, F., " Naturgeschichte des Herings." *Abhand. Deut. Seefischerei-Vereins.* Bd. ii. Heft 1. Berlin. 1898.

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therefore bears the distinct stamp of its race or stock; and that is the case not only in respect to a certain few particulars of its body, but, as one must admit, in all particulars, and at every stage of its development. A race can be recognised by the outer dimensions of the body as well as by the structure of the vertebral column, the form of the skull, or the special phases of its development" (p. lvii).

"The individuals of a race are in each character, as much as in the combination of all their characters, the fortuitous phases of an ideal type, which is exhibited in the averages of all the characters of all the individuals, and under supposition of a fixed amount of variation in each character" (p. xliv).

"All the individuals of a race have the same average deviation from the ideal type, but each is another permutation of the same series of deviations. The sum of the squares of the deviations from the race-type is the same for all, and is at the same time a minimum" (p. xliv).

"The head is much better adapted for the recognition of typical racial differences, which consist in the legitimate combination of numerous single characters, than the other parts of the body, because it is formed of many skeleton parts" (p. 210).

"Racial differences are found in the skull: they are not inferior to those observed in the races of man. The extreme brachycephalous skull of the Iceland herring has its antithesis in the impressed dolichocephalous skull of the spring-herring of the Eastern Baltic" (p. lviii).

Heincke's "attempt to draw up a natural grouping of the European herring-races shows that the difference between the coast-herrings and the sea-herrings must be deeply grounded in the constitution of the fish; it is with few exceptions associated with a difference in the time of spawning. The sea-herrings are summer- or autumn-spawners; the coast-herrings, winter- or spring-spawners" (p. lxvii).

"The spawning-shoal must be the starting-point of Race-Investigation: it is therefore necessary to examine as many spawning-shoals as possible" (p. xi).

"If the spawning-shoals which seek out the Schlei in the spring of each year are really the representatives of a special herring-race, defined by the fixed physical conditions of their dwelling-place, they must show the same race-characters from one year's end to another. To prove or refute this it will be necessary, in renewed research, to get spawning-shoals in different years, and if possible after an interval long enough, to avoid examining the same generation of the race as on the previous occasion" (p. xi).

"If spawning-shoals having the same race-characters appear yearly in the Schlei," Heincke concludes "that the fry of the Schlei herrings, when they have grown up to maturity, are accustomed to return to their birthplace to spawn" (p. xxvii).

"It is probable that the herrings in early youth live in shoals, which are composed of individuals pretty much of one age, since they were born on one spot and within a short spawning period. It is probable that a mixing of shoals of different ages occurs seldom, and then only for a short time. One may, therefore, conclude that

the majority of the individuals which compose a spawning-shoal are pretty much of the same age, particularly if they vary only slightly in size. If such a shoal be chosen, it will probably be possible to determine the family variation accurately enough without correction" (p. 88).

"The herring is a species restricted neither to water of a particular quality (salinity and temperature) nor to a specially fixed kind of food" (p. x).

All Heincke's "observations go to show that there must be a close connection between the characteristic peculiarities of the herring-race and the special physical and biological conditions of its dwelling-place" (p. lxxi).

"The salinity of the water has long been regarded as having the power of altering and limiting the form of marine animals" (p. lxxii).

"As a rule, races which are geographically widely separated, or better still, which are occupying regions which have physical dissimilarities (*i.e.* different environment), differ more in certain particulars than those which live together" (p. xxii).

"In going from west to east the salinity of the sea-water of the Baltic decreases, and this change is accompanied by a lessening of the constitutional size of the spawning herring, a reduction in the number of vertebræ and in the breadth of the skull, a shortening of the trunk, and increases in the lengths of the head and tail and of the distance between the dorsal and ventral fins. Are these significant peculiarities to be actually assigned to the direct or indirect operation of the lowered salinity ?" (p. lxxii).

"The herrings with the largest constitutional size, and with it the greatest number of vertebræ, live on the coast of the northern part of the North Sea, Norway, and Iceland. They are perhaps exposed directly to the influence of the salt ocean water (of the Gulf Stream). Is there here also a direct connection ?" (p. lxxiii).

"The herrings of the upper part of the Gulf of Bothnia may be ripe when 125 mm. long" (p. lxiv), whereas the smallest recorded mature Scottish herring was 170 mm. long.

"Herrings which grow up in very warm, shallow, brackish water, and, for example, in the Schlei and Zuider Zee, have an extremely low number of vertebræ to the first hæmal arch. Is this a direct consequence of the special conditions under which the fry develop ?" (p. lxxiii).

Heincke described the various races by means of measurements made on the body. As many as sixty-three different characters (p. 74) were noted from time to time. The following characters seemed to be of main value :—

1. Total length, viz., RT. (Fig. 1). It is measured on the principal axis of the body. The principal axis (*Pa*), is the line drawn from the anterior point of the lower jaw, when the mouth is closed, to the middle of the fork of the tail-fin. The end of the length-measurement, viz., *T*, is the intersection of the principal axis by the line at right angles to it. The latter cuts the lower ramus of the tail (which has been spread out in its greatest natural extension) a little in front of the apex, and passes the upper lobe a little behind the apex.

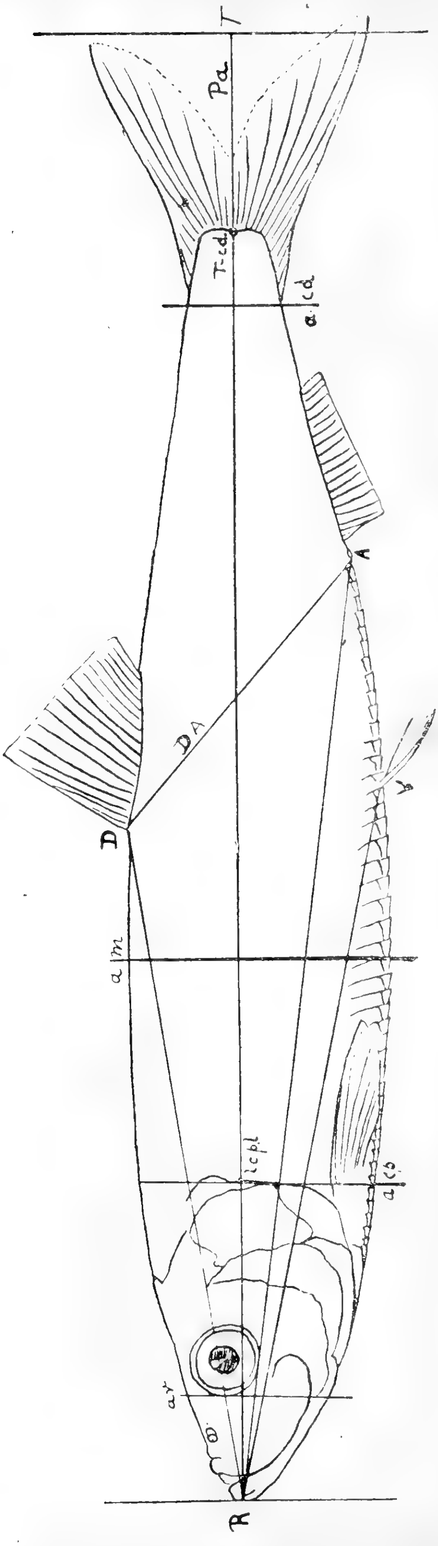

Fig. 1.—After Heincke. Measurements made on *Clupea harengus*

2. Size at maturity.

3. Distance of the dorsal fin from the end of the lower jaw (mouth closed). RD (Fig. 1).

4. Distance of the ventral fin from the end of the lower jaw (mouth closed). RV (Fig. 1).

5. Distance of the anus from the end of the lower jaw (mouth closed). RA (Fig. 1).

6. Length of the base of the anal fin.

7. Length of the base of the dorsal fin.

8. Lateral length of head, viz., from the point of the lower jaw to the hindmost point of the gill-cover. *lcpl.* (Fig. 1).

9. Form of snout.

10. Upper length of skull. *lcr.* (Fig. 2).

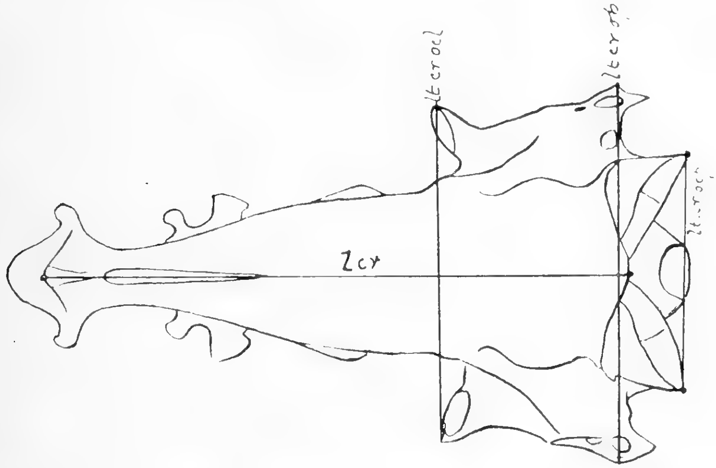

Fig. 2.—After Heincke. Measurements made on *Clupea harengus.* Skull.

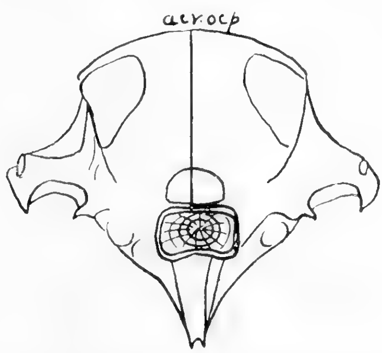

Fig. 3.—After Heincke. Measurements made on *Clupea harengus.* Skull.

11. Breadth of skull, e.g. *lt. cr. ocl.*, and *lt. cr. op.* (Fig. 2).

12. Shape of head. Length-breadth index of the skull.

13. Length of trunk.

14. Length of tail.

15. Size of the eye. Greatest horizontal diameter of the eye-bulb.
16. Distance between the dorsal and ventral fins.
17. Number of rays in the ventral fin.
18. Number of vertebræ. The last vertebra counted is the first vertebra that distinctly bends upwards.
19. Number of vertebræ to the first hæmal arch.
20. Number of tail-vertebræ.
21. Number of keel-scales between the ventral fin and the anus.
22. Breadth of operculum.

Complete sizes, with the exception of the total length, were measured in a straight line by means of callipers.

The greater errors are those of measurement, made, for example, on fresh or spirit-preserved specimens. All the errors are large when made on soft parts.

Method of Treating the Measurements.

All the measurements are expressed as percentages of certain body-dimensions, *e.g.* total length, or lateral length of the head, or the upper length of the skull (p. 80).

The average size of each character is calculated for the group of herrings examined. The average for the whole race is approximately deduced by the aid of the curve of probability. Two quantities (the fluctuations of the mean) are obtained, between which the mean for the race is supposed to lie. If the fluctuations of the mean for a character in two shoals of herrings do not overlap, the character is considered to be racially distinct in the two shoals.

"The application of the method of combined characters to the different herring-races which have been so far investigated yields a sure natural system, which is sketched below" (p. lix.) Heincke remarks that the system is only a provisional one.

Heincke distinguished among the European herrings the following ten groups, some of which consisted of more than one race :—

1. Herrings of Iceland.
2. Spring-herrings of Norway.
3. Spring- and coast-herrings of the northern part of the North Sea and of the Skagerak.
4. Spring- and coast-herrings of the southern part of the North Sea and west part of the Baltic including the Kattegat.

4*a*. Spring-herrings of Rügen.

5. Autumn- or sea-herrings of the northern part of the North Sea, including the Skagerak and Kattegat. Northern bank-herrings.
6. Autumn- or sea-herrings of the southern part ot the North Sea. Southern bank-herrings.
7. Autumn- or sea-herrings of the Baltic. Baltic bank-herrings.
8. Spring-herrings of the eastern part of the Baltic.
9. Herrings of the English Channel.
10. Herrings of the White Sea.

THE INVESTIGATION BY MATTHEWS.

Matthews * tested the problem of the existence of races among the Scottish herrings.

He used a similar method to that adopted by Heincke, but he made the comparison between the shoals by the aid of the observed averages of the measurements. He examined 1100 herrings.

The characters selected by Matthews were :—

1. Length. The length was the distance from the tip of the lower jaw, when the mouth was closed, to the point where the silvery sub-epidermic layer covering the body terminates. The latter point was called the base of the caudal fin.

The fish was, on arrival, placed on a sheet of paper in such a position that a straight line would run through the tip of the closed lower jaw and the fork of the tail. A pencil was carried round the fish, so that a rough but fairly accurate life-size sketch was formed of it. The following points were then accurately marked off :—

2. Anterior end of the mandible.
3. ,, ,, ,, premaxilla.
4. Centre of the eye.
5. Back of head, of supra-occipital bone, which has an almost straight posterior border. This forms a much better standard of length of the head than the length of the side of the head, which includes the opercular bone—liable to considerable alteration in position from various causes.
6. Base of anterior ray of dorsal fin.
7. Base of posterior ray of dorsal fin.
8. Termination of the tail (as described above).
9. Tip of the caudal fin.
10. Base of the posterior ray of the anal fin.
11. Base of the anterior ray of the anal fin. This point has nearly always the same relative position with regard to the anus, any difference being more apparent than real, occurring especially during the spawning season from the enlarged and tumid condition, and from its contracted state in the spent condition.
12. Base of the first ray of the pelvic fin.
13. End of the branchiostegal membrane.
14. Articulation of the lower jaw.
15. Number of rays in the dorsal fin.
16. ,, ,, ,, anal fin.
17. ,, ,, ,, caudal fin.
18. ,, ,, ,, pectoral fin.
19. ,, ,, ,, pelvic fin.
20. Number of keeled scales.

The condition of the reproductive organs was noted.

The measurements were all reduced to ratios of the length of the fish.

The fishes were all perfectly fresh when measured. They had

* Matthews, J. D., "Report as to Variety among the Herrings of the Scottish Coasts." Pt. I. 4th *Annual Report of the Fishery Board for Scotland* for 1885. (1886.) P. 61. Pt. II. 5th *Annual Report of the Fishery Board for Scotland* for 1886. (1887.) P. 295.

b

been taken by fishermen at various places round the Scottish coast during spring, summer, and winter.

Matthews found "that fishes of the same length and as nearly as possible of the same bulk differed as to their dorsal and anal fins, not only in the position of these relatively to the length of the body, but that the fins themselves varied both as to the length of their bases and also in respect to the respective lengths of the individual rays measured from their bases to their tips; a circumstance due not only to the different amount of wear they had undergone, which is probably slight, but also to absolute difference in the amount of their development, increased, as it likely is, by the difference in age of the fish. In several cases it was clear that the length of the caudal fin was affected by wear or by injury received after the capture of the herring. But a far greater difference was found in the actual length of the caudal fin-rays as measured from their proximal ends, and also from the termination of the intervening and supporting hypural bones in herrings as nearly alike as possible in the length and bulk of their bodies."

"It was evident also that the fishes were subject to very considerable variation in the position of the lobes of the caudal fin, caused apparently by the amount of muscular contraction after death, and as a consequence of this, there of course resulted a considerable degree of variation in the total length of the fish (sometimes as much as 10 mm.), according to whether the lobes were approximated so as to be nearly in a straight line behind the body, or were widely spread."

"The depth of the mature herring caught during or near to the time of spawning is almost wholly influenced in its extent by the condition of the reproductive organs, and so many variable degrees of these are found that any measurement of the depth of the body proper is most unsatisfactory as a test of the size of the fish. There is, however, a point which gives a fair index of the size of the fish in this respect, and which is but very little affected by the size of the generative organs. This is the depth of the fish at the anterior end of the body in a line with the back of the head, the upper point being fixed by the dorsal surface of the supra-occipital bone, the lower by the ventral edges of the clavicles."

Size of the Fish.—"We can scarcely distinguish, as regards size, the herring of any particular locality, or perhaps even seasons, by a preference over the others without further confirmatory evidence, such as might be brought out by an examination of differences in other characters and the common presence of one or more of such, specially in the fish of any one place or season.

Length of the Head.—"The measurement of the length of the head in comparison to the total length is extremely variable. If we do not consider the slight difference in total length found between the winter- and summer-herrings sufficient to indicate a distinct variety, neither is there stronger evidence from the length of the head."

Position of the Pectoral Fin.—"There seems to be little difference in the position of this fin on the summer- and winter-herrings, the winter-fish having it, if anything, slightly farther back than the summer-fish."

Position of the Pelvic (Ventral) Fin.—"The pelvic fin of the winter-

herring is in the majority of instances placed further forward than in the summer-fish."

Position of Dorsal Fin.—"It appears that, as the herring grows, the centre of the length of the body comes forward, or, in other words, there is a greater increase in length between the centre of the dorsal fin and the head than between that point and the tail. It does not seem possible to find any special law regulating the position of the dorsal fin among the summer-herrings so far as locality is concerned."

Position of the Anal Fin.—"In finding the position of the first anal ray we are ascertaining the position of the anus. The circumstance that the anal fin holds as a general rule a more backward position on the summer-herring than it does among those of winter fairly entitles us, I think, to look upon the suggestion of the difference in relative position of the dorsal fin being distinctive of the fish of these seasons as substantiated."

Length of the Dorsal and Anal Fins.—"The average of the absolute length of both dorsal and anal fins was greater among the winter- than among the summer-herrings,—a circumstance possibly due only to the rather larger size of the winter-fish."

Number of Rays in the Dorsal and Anal Fins.—Matthews' "observations of the number of rays in the fins, so far as they went, gave no indication of any special distinction in this respect between the herrings of winter and summer. There seems to be a slight tendency towards an increase in the number of rays (always excepting those of the pelvic and caudal fins) as the herring grows larger. The number of rays in the dorsal and anal fins does not seem to much affect their basal lengths."

Keeled Scales.—Matthews' "observations did not so far enable him to detect such a difference between the respective numbers of the keeled scales as Heincke has done in the Baltic herring, and which enables him to quote them as of racial distinction."

Sexual Differences.—"No difference in regard to the size of the head, size of the fish, etc., was discovered between the male and female herrings."

Variation in Size of the Ripe Ova.—"The ripe ova showed an increase in their average size corresponding to increase in the size of the fish. It seemed" to Matthews "that the variable size both of the spawning-herring as well as of their ova probably has a considerable effect on the ultimate size of their progeny, but one can scarcely institute a special case of variety on these grounds alone if the smaller fish have every other characteristic in common with the larger herring. The ova of one herring is almost certain to be fertilised by several males."

"Without a more critical examination than has yet been made it would be unwise to speak definitely on the question of variety among the herrings of our coasts. The only evidence as yet found from the present investigation in favour of such a distinction between the summer- and winter-herrings consists in the more posterior position of the dorsal, pelvic, and anal fins, the undoubtedly smaller head, and the slightly lesser size of the summer-herrings."

"While suggesting, therefore, that there is a certain distinction between our summer- and winter-herrings," Matthews was "indisposed to consider the matter as conclusively proved without the

facts being submitted to a more minute analysis." He felt "safer in declaring that there is no racial distinction between the herrings frequenting the different localities on the Scottish coasts."

Matthews, in the second part of his paper discussing the comparison of the herrings by means of combinations of characters :—

"The further examination of the characters already dealt with, but taken in combination, with one or more others, does not seem to so seriously affect the results recorded in the first part of the paper as to alter the probability of the conclusions arrived at; but it must be remembered that so far as they go they slightly tend to reduce the probability of the distinction of species [? race] considered to exist between the winter- and summer-herrings."

"The only combinations which, in the comparatively narrow variations recorded, have much interest, or indeed are common enough to be of any value, are those of two characters. When the combination of certain definite conditions in more than two characters on the same fish is looked for, the number of individuals having what may be called the normal state of these combination is so much reduced as to lead to results of no special value."

"We have in most of the characters a more or less common ground of variation, *i.e.* a region in which the character appears so commonly as to be entitled to the term 'normal,' and an extreme of variation on one or both sides of this and more or less great."

"Taking the summer- and winter-fish separately, or both combined, we invariably find that the majority have a central ground of variation, while the numbers decrease gradually to the extreme on each side of this common area. Had a considerable portion of the fish been found showing an extreme of two or more characters while another set presented a markedly separate condition, it would be almost certain evidence of racial distinction, but none such is to be found in the herrings examined."

"The examination of a large number of the different combinations in which two characters are found on the individual fish led" Matthews "to the conclusion that no racial distinction is shown by these alone, *i.e.* when the season in which they were caught is ignored, for there is a gradation towards each extreme of the variations which connects all the fish together."

"When we come to a combination of more than two characters, the third character is found so scattered throughout the combinations of the others that no value can be placed on it."

"The position of the pectoral fin varies indiscriminately and irrespective of the condition of the dorsal and anal, and is therefore not of racial value."

"The shorter of the sexually mature fish are found, as a rule, to have the longer head. This is found to occur in both the summer- and winter-herrings. It seems quite clear that the decrease in the proportional length of the head to the length of the body is a result of increase of size, and presumably therefore of the age of the herring, and is not an indication merely of variety."

"In all the cases examined the total length of the vertebral column was carefully measured, the result showing conclusively that its total length was unaffected by the number of vertebræ."

Matthews refers "to the mistake of supposing that herrings are

of a different race, because after a single season's examination they are seen to be, in general size or otherwise, different from those of another locality about the same time or at different seasons. To decide as to this effectually, continuous observations over several seasons is essential, and" he was conscious "that, in this respect," his "own observations, although they had extended over three years, were still insufficient: but at least they indicate how changed, in of course a limited degree, the herrings of one and the same locality but of different years may be. Much safer it is, where the difference between individuals is so slight or so obscurely separated as not to permit of a short examination clearly demonstrating its racial origin, to doubt rather than infer its accuracy." He felt "pretty sure that the variations just referred to are not permanent, but are due to the varying conditions of food and temperature affecting the young herring, as well as to the probable variability in size and age of its parents."

"The conclusion at which" he arrived "from these observations was that there is no true racial difference between the herrings of the various localities around our coasts; and while the investigation points towards a distinction between the herrings frequenting our shores in summer and winter, it is so small, not only in its actual extent, and more especially in the circumstance that there is no sharp line of distinction between the two, but that many of the summer-herring are found to be marked by the same characteristics as those of the winter, that he did not feel justified from the investigation in considering this to be a well-proved fact."

Jenkins discusses Heincke's separation of the spring- and autumn-spawning herrings.

Suggestions as to Future Work.

Heincke has shown that races exist among the herrings of Europe. The problem is to extend and confirm his observations.

It is not possible to say what is the best method to follow in investigating the race-problem. It may happen that a method which is useful in separating two races which occupy very dissimilar environments may not be of equal value in separating shoals which live under conditions that differ only slightly.

It is probably well to carry out the investigation on lines similar to those adopted by Heincke and Matthews, *i.e.* by means of a comparison made through body-measurements, enumeration-characters, etc.

Heincke recommended that the spawning-shoal be taken as the starting-point for race-investigation, and there can be no doubt this is the correct method. The adoption of this condition would furnish fishes all of one class, and fully comparable *inter se*.

The fishes should be spawning, or "full" fishes. Five hundred fishes is suggested as the number that would give a suitable sample of the shoal, but a larger number would probably be advantageous. Spawning herrings are those in which the reproductive organs are so far ripe that the ova and milt issue by the genital pore when the abdomen is gently pressed. In the event of spawning herrings not being available,

full herrings got near the spawning-ground should be taken. A herring is full when the ovary or testis is large enough to fill up the abdomen and give the latter a firm, resistent feel. The term "full" may be conveniently restricted to females in which the eggs are 1·0 mm. and over in diameter and to males in which the testis is 2 cm. and over in breadth. Small males were full although the testis did not reach that breadth. For example, one full herring 17 cm. in length had a testis 1 cm. in breadth. The herrings should be all taken from one shot, or from one fishing made at the spot. Full and spawning herrings should be dealt with separately.

The herrings should not be measured while they are in *rigor mortis*. They should be preserved in formaline. Cold storage might be preferable, but that is not always available. The following method of preservation suggests itself. The fishes should first of all be placed loosely in troughs containing formaline solution (1 per cent. of formaldehyde in fresh water), care being taken to avoid distortion of the fishes as far as possible. After being one day in the troughs the herrings are to be removed and laid out, being straightened if necessary, on boards with their left side upwards. They are left there for twenty-four hours. They are then returned to the troughs, which have been supplied with fresh formaline solution. A knife cut about 1 cm. long should be made through the abdomen about the level of the pectoral fins. The knife should pass right through the fish, through the stomach or pyloric cæca.

In order to test the effect on the measurements of the preservation of the fish in formaline, a series of characters were measured on six fresh herrings. The fishes were thereafter preserved in formaline solution (1 per cent. formaldehyde in fresh water) for twenty-three days. They were then remeasured, and the results are shown in the accompanying table. The letter "A" refers to the measurements made on the fresh fishes, and "B" to these made on the preserved fishes.

[TABLE.

TABLE I.—Comparison of Measurements made before and after preservation in formaline. Measurements in centimetres.

No.	Length, cm.	Girth. At Dorsal Fin.	Girth. At Root of Tail.	Eye. Diameter. Iris.	Eye. Diameter. Pupil.	Length. Pectoral Fin.	Length. Ventral Fin.	Dorso-ventral Height of Dorsal Fin.	Length of Dorsal Ramus of Tail.	Distance from Tip of Lower Jaw. Anterior Edge of Pupil of Eye.	Supra Occipital Ridge.	Opercular Cleft.	Hind Edge of Gill-cover.	Pectoral Fin.	Ventral Fin.	Dorsal Fin. Beginning.	Dorsal Fin. End.	Anal Fin. Beginning.	Anal Fin. End.	Beginning of Dorsal Ramus or Tail.	Point of Greatest Height of Dorsum above PA., and the Height.		Point of Greatest Depth of Ventrum below PA., and the Depth.	
1A	26	13·8	4·1	1·1	·5 × ·65	3·4	2·3	2·35	5·3	2·1	3·7	4·1	5·2	4·9	13·8	13·2	16·1	19·1	21·8	23·25	10·5	2·6	8·6	2·9
1B	...	13·9	4·6	1·1	·5 × ·7	3·55	2·45	2·15	5·3	1·8	3·8	4·2	5·1	5	13·75	13·1	16·1	19	21·75	23·35	10·9	2·55	11	3·05
2A	28	14·5	4·5	1·2	·6 × ·7	3·8	2·5	2·6	5·8	2·05	3·75	4·1	5·35	5·2	14·6	13·5	16·7	20·2	23·4	25·1	13·5	2·75	11·2	3·9
2B	27·9	15·3	4·6	1·3	·5 × ·65	3·8	2·6	2·15	5·75	20·5*	3·85	4·2	5·4	5·25	14·5	13·45	16·7	20·15	23·35	25·05	12·6	2·85	11·5	3·4
3A	27·4	14·4	4·7	1·15	·5 × ·6	3·8	2·5	2·7	6·05	2·1	3·9	4·15	5·35	5·25	14·35	13·4	16·9	19·6	22·8	24·45	10·8	2·5	12·35	3·6
3B	27·25	14·7	4·5	1·25	·45	3·8	2·6	2·6	6	1·8	3·8	4	5·25	5·25	14·4	13·1	16·6	19·4	22·55	24·15	12·8	2·95	9·5	3·15
4A	27·5	14·4	4·5	1·15	·55 × ·6	3·75	2·4	2·6	5·9	2·1	3·9	4·15	5·45	5·2	14·5	13·45	16·8	19·8	23	24·5	13·2	2·7	10·7	3·4
4B	27·3	14·8	4·55	1·15	·55 × ·65	3·75	2·5	2·45	5·9	2	3·85	4·05	5·15	5·2	14·3	13·3	16·65	19·55	22·7	24·4	11·5	3	13·7	2·85
5A	25·9	13	4·3	1·05	·55 × ·6	3·55	2·35	2·4	5·5	2·05	3·75	4·05	5·3	5·15	13·9	13	15·95	18·7	21·7	23·1	13·1	2·9	11·8	2·8
5B	25·8	13·3	4·2	1·05	·5 × ·65	3·65	2·4	2·3	5·5	2·2	3·8	4·3	5·45	5·15	13·85	12·95	16	18·7	21·6	23·1	10·4	2·75	12·2	2·8
6A	27·3	14·3	4·45	1·1	·5 × ·55	3·7	2·5	2·5	6	2·05	3·8	4	5·25	5	14·2	13·45	16·7	19·65	22·75	24·15	13·1	2·1	11·9	3·95
6B	27·2	14·35	4·7	1·15	·5 × ·6	3·65	2·5	2·35	6·05	2·05	3·8	4·05	5·05	4·9	14·1	13·4	16·55	19·65	22·8	24·1	10·5	2·2	11·1	3·6

* This is evidently a clerical error for 2·05.

The flesh of the fish was swollen as a result of the preservation.

While some of the measurements are altered to a substantial amount, others are little, or not at all changed.

The condition compares favourably with the effect of cold-storage. Six mackerel were used to test the effect of freezing the fish. They were frozen and kept in a cold store for twenty-five days. Measurements made before and after freezing are detailed in a table, published in the Eighteenth Annual Report of the Fishery Board for Scotland, Part III., page 300. I have extracted the particulars dealing with certain characters which are comparable in the two series (herring and mackerel), and they are set out in the following table.

TABLE showing the alteration in measurement due to preservation in formaline in the case of Herring, and of freezing in cold store in the case of the Mackerel.

Character.	Greatest Change in Measurement—*per cent.*	
	Herring (*Clupeaharengus*).	Mackerel (*Scomber scombrus*).
Length	$-\cdot 7$	-1
Girth at dorsal fin	$+5$	-5
Do. root of tail	$+5$	-11
Length of pectoral fin	$+4$	$-2\cdot 5$
Lateral length of head	$-5\cdot 4$	$-3\cdot 7$
Distance of pectoral fin	± 2	-3
Do. ventral fin	$-1\cdot 3$	-2
Do. dorsal fin	$-2\cdot 2$	-3
Do. anal fin	$-1\cdot 2$	-2

Taken all over the method of preservation with formaline seems to be about as satisfactory as keeping the fishes in cold store.

Dr. Fulton suggested that even where the fish is still fresh, a single observer might not, on repeating his measurements, obtain exactly the same results. In order to test this I made two series of measurements in one day on three fresh herrings measuring respectively:—25·1 *cm.* ♂: 27·35 *cm.* ♀: 29·8 *cm.* ♂. The fishes were in the spawning condition. The results are shown in Table II. They are set out as the actual difference, and as the percentages which the difference bore to the measurement and also to the length of the fish. In the compartments of the Table in which there is no figure, the figure "0" is to be understood.

TABLE II.—Differences between two series of Measurements made on three fresh herrings.

	Length.	Girth.		Eye.		Length.		Dorso-ventral Height of Dorsal.	Length of Dorsal Ramus of Tail.	Distance from Tip of Lower Jaw.											
		At Dorsal Fin.	Root of Tail.	Diameter, Iris.	Diameter, Pupil.	Pectoral Fin.	Ventral Fin.			Anterior Edge of Pupil.	Supra Occipital Ridge.	Top of Opercular Cleft.	Hind Edge of Gill-cover.	Pectoral Fin.	Ventral Fin.	Dorsal Fin. Beginning.	Dorsal Fin. End.	Anal Fin. Beginning.	Anal Fin. End.	Beginning of Dorsal Ramus or Tail.	Depth of Fish.
Least difference, in mm.	...	1·5	...	...	...	...	·5	...	1	...	...	·5	...	...	1·5	...	·5	...	...	...	·5
Greatest difference, in mm.	1	7·5	1	·5	·5	1·5	·5	1	1·5	·5	1	1	·5	...	2	1	·5	3	1·5	1·5	3
Least difference, as a percentage of the measurement	...	+1·2	...	...	...	...	+1·9	...	+1·9	...	...	+1·2	...	...	−1	...	−·2	...	...	...	−·8
Greatest difference, as a percentage of the measurement	−·3	+5·7	−2·4	−4·7	+8	+3·8	−2	−4	+2·6	+2·5	−2·5	−2	+1	...	−1·3	+·8	+·3	−1·6	−·7	−·5	−4·8
Least difference, as a percentage of the length of the fish	...	·5	...	...	...	...	+·16	...	+·3	...	...	+·18	...	...	−·5	...	−·17	...	...	...	−·2
Greatest difference, as a percentage of the length of the fish	−·3	+2·5	−·4	−·2	+·18	+·5	−·2	−·3	+·5	+·18	−·3	−·3	+·2	...	−·7	+·3	+·2	−1	−·6	−·5	−1

The differences are, on the whole, not very large: in some cases identical measurements were obtained. The differences are due to slight alterations in the body of the fish. It is probably not possible to make the true measurement, because the fish, when laid on its side, is contorted slightly. In the case of the mackerel instances occurred where a character had different sizes on the two sides of the fish.

Certain characters must be noted on the fishes in a fresh condition. These characters are Nos. XXXI., XXXII., XXXV., and XXXVI., p. 21, and with them the length of the fish should be noted. An additional number of herrings (100 at least) should be used for this purpose. In the case of fishes which are preserved in formaline, it is difficult to separate the flesh from the skeleton. If the fish be boiled the skull becomes distorted.

Drift net herrings are often injured. Where this is evident the fishes should be rejected, so far as the measurements that are likely to be affected thereby are concerned.

Racial Description.

The herrings are to be racially described by the body-characters. These are of two kinds, viz. (1) Measurements on the outside of the body and on parts of the skeleton, and (2) Enumeration-characters, etc.

In order that the results obtained by different writers be comparable, it is important that the same list of characters should be adopted by all the investigators, or that there should be a minimum of common characters, while each investigator might add thereto whatever additional characters he might regard as suitable. The larger the number of characters selected the better.

Further, in the case of the body-measurements, a uniform system of measurement should be adopted. It is not possible to have very minute accuracy in measuring soft bodies: it is well, therefore, to reduce as much as possible the tendency to error, and with that end in view I would suggest the use of the measuring-board * shown in Figs. 5 and 6. By its means the distance of a point from the tip of the lower jaw is given as the projection of the distance on the principal axis.

Characters.

The measurements are to be made in millimetres :—

I. The length of the fish, viz., from the tip of the lower jaw (mouth closed) to the end of the shortest ray in the fork of the tail fin.

II. Sex.

III. Maturity, in case of herrings which are not spawning. Breadth of the reproductive organ. Size of the largest ova.

IV. Girth immediately in front of the dorsal fin.

V. Girth at the root of the tail.

The girth is measured by means of a thread drawn gently tense

* Williamson, H. C., "On the Mackerel of the East and West Coasts of Scotland." 18th *Annual Report of the Fishery Board for Scotland* for 1899. Pt. III. 1900. P. 296 *et seq.*

round the fish. The ends of the thread are made to overlap, and they are then cut across by means of a sharp knife (Fig. 4).

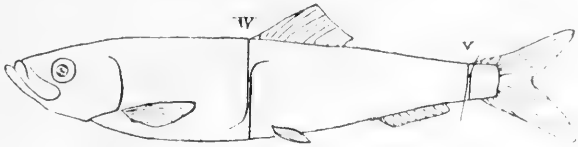

FIG. 4.—Diagram of Herring to indicate positions of the Girth Measurements.

VI. Horizontal diameter of the iris and pupil. The iris is co-extensive with the silvery iridescent region. The pupil is oval and requires two measurements, viz., long and short axes.

VII. Length of the pectoral fin, *i.e.* the distance from the articulation of the first ray (dorsal side) to the most distant point of the fin.

VIII. Length of the ventral fin, *i.e.* the distance from the articulation of the first ray to the most distant point of the fin.

IX. The greatest dorso-ventral height of the dorsal fin, when it is spread out to its greatest extent. One point of the dividers rests on the top of the interspinous bones between the bases of the fin-rays immediately below the highest point of the fin.

X. Length of the dorsal ramus of the tail fin, measured from the point of beginning of ramus defined in XXVI. to the tip of the ramus.

Characters VII. to X. are measured by means of dividers.

XI. The number of rays in the pectoral fin.
XII. ,, ,, ,, ventral ,,
XIII. ,, ,, ,, dorsal ,,
XIV. ,, ,, ,, anal ,,

XV. The number of keel-scales from and including the keel-scale situated between the bases of the ventral fins to the anus.

DISTANCES OF CERTAIN POINTS FROM THE TIP OF THE LOWER JAW.

For the following characters the herring is placed on the measuring-board, so that the principal axis (*i.e.* the line drawn from the lower edge of the turned-down lip on the anterior end of the lower jaw to the middle of the fork of the tail) coincides with a line drawn on the board, and also with the thread stretched longitudinally over the board (Fig 5). The mouth of the fish is to be closed. It may be an advantage to fix the fish by means of long needles passed through the fish and into the board. The travelling T-square is moved along till the thread (or horse-hair), the point on the fish, and the needle-point, which is vertically below the thread, are, as near as the eye can judge, in one plane. The distances are read off by means of the needle-point which travels over the scale.

XVI. Anterior edge of the pupil of the eye.

XVII. Posterior edge of the flattened area on top of the head. The hind edge of the transverse ridge (upper edge of supra-occipital

bone), which marks the beginning of the scales on the nape of the neck, is taken for the point.

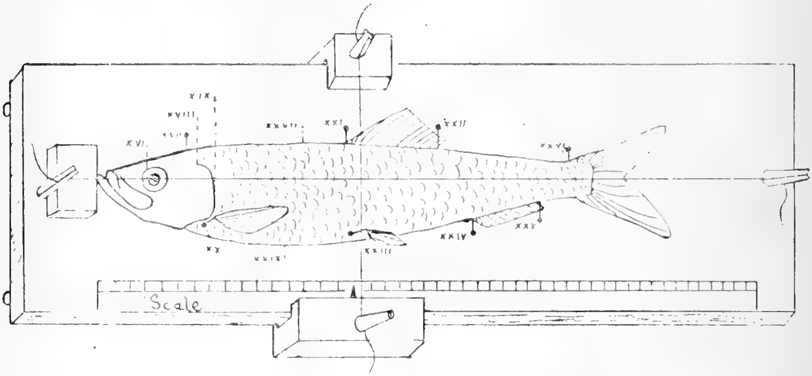

FIG. 5.—Measuring Board.

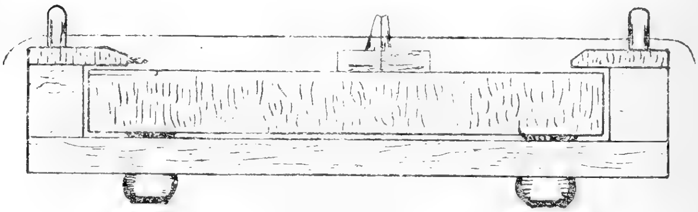

FIG. 6.—Travelling T-square.

XVIII. The top of the opercular cleft. A pin is put into the cleft in its extreme anterior upper angle. The pin is then the point for the measurement.

XIX. Hindmost point of the bony edge of the gill-cover. A piece of paper placed under the edge helps to define it.

XX. The articulation of the first ray of the pectoral fin. A pin inserted into the articulation is the point.

XXI. Beginning of the dorsal fin. The membrane uniting the first two rays from the third is cut. The two first rays are raised into a vertical position. A cut is then made in the dorsal edge of the body by sliding a knife down the front edge of the first ray. A pin inserted into the cut constitutes the point.

XXII. End of the dorsal fin. A pin is inserted into the dorsal edge of the body immediately behind and close to the base of the last ray.

XXIII. Articulation of the first ray of the ventral fin. The point is marked by a pin inserted into the articulation.

XXIV. Beginning of the anal fin. The point is marked in a manner similar to that in XXI.

XXV. End of the anal fin. A pin is inserted in the dorsal edge of the body immediately behind and close to the base of the last ray.

XXVI. Beginning of the dorsal ramus of the tail fin. If the dorsal edge of the body in front of the beginning of the dorsal ramus be scraped free of scales, a little cartilaginous ray-like body is seen in the skin. The anterior point of this body is marked by a cut into

which a pin is inserted. The pin is taken as the position of the point.

XXVII. The point where the dorsal edge reaches its greatest height above the principal axis.

XXVIII. The height above the principal axis at this distance is measured by dividers.

XXIX. The point where the ventrum reaches its greatest depth below the principal axis.

XXX. The depth below the principal axis at XXIX. measured by dividers.

Nos. XXVIII. and XXX. together give the depth of the fish.

Skeleton.

XXXI. The upper length of the skull, *i.e.* the distance from the front vertical edge of the ethmoid to the hind upper edge of the supra-occipital bone, viz., *lcr*, Fig. 2.

XXXII. Greatest breadth of skull, viz., *ltcrop*, Fig. 2.

Nos. XXXI. and XXXII. are measured by means of callipers.

The length divided by the breadth of the skull is the index of the form of the skull.

XXXIII. The number of vertebræ. The last vertebra is B in Fig. 7. *Not?* = Notochord ?

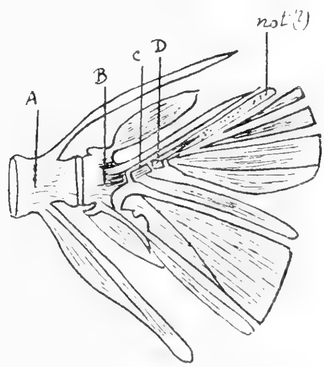

Fig. 7.—Diagram of Tail-bones of Herring.

XXXIV. The number of the vertebra bearing the first hæmal arch.

XXXV. Weight (Grammes).

XXXVI. Colour of the flesh.

The measurements are to be converted into percentages of the length of the fish. All the measurement-characters of a fish are converted into percentages by multiplying them by the same factor, viz., $\frac{100}{\text{length of the fish}}$. This is readily accomplished by means of Crelle's tables.

The average of the percentages for each character is to be calculated.

It is possible that one may be able to compare certain shoals by the observed averages, or by combinations of averages. The curve of probability is mainly of value for the calculation of the average, when only a few fishes are available for examination.

The means and fluctuations of the means should, however, also be calculated.

The Observer and the Personal Error.

It would be well if each investigator limited his work to the herrings frequenting one spawning-ground. He should make all the observations and measurements. He might receive assistance in the subsequent mathematical calculations. The investigators should meet and discuss the results. The relation between their personal errors should then be determined by experiment.

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Explanation of Figures.

Fig. 1. Diagram of herring, showing some external measurements. (After Heincke.)

,, 2. Dorsal view of skull, to exhibit measurements. (After Heincke.)

,, 3. Hind view of skull, to exhibit measurement. (After Heincke.)

FISHERY BOARD FOR SCOTLAND.

SCIENTIFIC INVESTIGATIONS,

1914.

No. II.

THE DISTRIBUTION OF PLAICE EGGS IN THE NORTHERN NORTH SEA.

(FROM THE COLLECTIONS MADE BY THE FISHERY RESEARCH VESSEL "GOLDSEEKER" DURING THE MONTHS NOVEMBER TO MARCH IN THE YEARS 1904 TO 1913 INCLUSIVE.)

(WITH 5 TEXT-FIGURES AND CHART.)

BY ALEXANDER BOWMAN, D.Sc., ABERDEEN.

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THE DISTRIBUTION OF PLAICE EGGS IN THE NORTHERN NORTH SEA.

(From the collections made by the Fishery Research Vessel "Goldseeker" during the months November to March in the years 1904 to 1913 inclusive.)

By ALEXANDER BOWMAN, D.Sc., Aberdeen.

Plaice (*Pleuronectes platessa*) are distributed in the shallower zones all round the Scottish Coast. While usually found in depths of less than fifty fathoms, a few individuals are sometimes taken in deeper water. Professor D'Arcy W. Thompson (1913) gives two charts which illustrate by means of contour lines the quantities of plaice captured per 100 hours fishing by Aberdeen trawlers in the Northern North Sea, the quantities represented being the means of the period 1901–1910. His general conclusion is given as follows :—" The region throughout which the catch of plaice is for the most part insignificant corresponds pretty closely with that part of the North Sea which is over 50 fathoms deep ; that region where the catch varies from 5 to 10 cwts. per 100 hours trawling coincides equally closely with the zone of depth from about 30 to rather less than 50 fathoms while in the region under 30 fathoms in depth we find mean catches of plaice that exceed 10 cwts. per 100 hours" (p. 65). And again :—" The charts show how the small plaice are practically absent in our deeper waters, and how both actually and relatively to the other sizes they increase in numbers as we pass to the shallower zones" (p. 65).

Dr. Fulton (1913) states that in the Northern North Sea " the greatest density of plaice is along the eastern coast of Scotland and around the Northern Isles, and the next greatest density is in the area lying in the neighbourhood of the Great Fisher Bank and towards the Danish Coast. In the areas between the two, where the depths are greater, as well as the distance from the shore, the abundance of the plaice is much less" (p. 123).

The area examined by the " Goldseeker" in the Northern North Sea during the period under observation extends far beyond the limits of the distribution of adult plaice. The stations visited are shown in the accompanying chart, and the number of times each station has been sampled in December, January, February, and March respectively, during the ten years, is given in tabular form. Over such a wide area some localities have necessarily been visited much less frequently than others.

At all the observation stations the collections were made with conical cheese-cloth nets, having a diameter of one metre. The texture of the

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cheese-cloth material is very uniform, the average diameter of the thread being about ·3 mm. and on the average 90 meshes per square cm. This material is of a texture sufficiently fine to capture the smallest fish eggs occurring in the plankton. At most of the stations a vertical haul as well as horizontal hauls at surface, mid-water, and bottom layers were taken with these nets. On many occasions hauls were also taken with the Petersen Young Fish Trawl, but the texture of the material of this net was often too open to retain fish eggs.

The tow-net material when collected was immediately preserved in 4 per cent. formalin solution in sea-water, and after a longer or shorter interval the larval fishes and fish eggs were selected and transferred to a $2\frac{1}{2}$ per cent. formalin solution. With the exception of the 1913 collections the eggs were not examined carefully until they had remained more than a year in formalin. Such eggs have been sufficiently long in formalin to reach their maximum shrinkage, and in comparing their sizes with eggs from other sources this fact must not be forgotten.

In the initial stages of development many of these pelagic eggs, which become opaque when preserved in formalin, are almost characterless, except as regards size. The following method has been adopted in dealing with the different collections. The eggs were separated into two groups according as to whether they had or had not contained oil-globules. It is only in the collections made towards the end of March and in the later months that relatively large eggs, with oil-globules appearing in the plankton, might possibly be confused with plaice eggs on account of their size. But the presence or absence of an oil-globule in any particular specimen may be determined by examination under the microscope, and even if the oil has been extracted by the preserving fluid the cavity in which the oil originally lay may still be detected.

In the Northern North Sea during the period under observation eggs without oil-globules have a wide range in size, varying in diameter from ·7 mm. to over 2 mm. Some, for example, those belonging to the Dragonet (*Callionymus sp.*) and the Long Rough Dab (*Drepanopsetta platessoids*) may be separated directly. The Long Rough Dab egg is very easily identified both in the living condition and in preserved material as the large perivitelline space within the egg is characteristic. In the preserved material Long Rough Dab eggs usually appear very buoyant and semi-transparent owing to their relatively small amount of yolk. When the large perivitelline space is indistinct a very small percentage may, however, be confused with plaice eggs as the ranges in size overlap, but the thin character of the capsule of the Long Rough Dab egg is readily seen under the microscope. Further, eggs such as those of the haddock and cod are also easily identified when the contained embryo has reached a certain stage in development.

All eggs in the initial stages of development have been measured under the microscope with the aid of a micrometer eye-piece, ninety divisions of which are equivalent to 2 mm. It is interesting to find that when eggs without oil-globules from any locality for a particular period of the year are arranged according to diameter they fall into natural groups, and that in successive years these groups are almost identical. Two illustrations are given (see Figs. 1, 2, and 3) for February 1905 and February 1907. The groups are almost identical, although the relative numbers within the different groups vary from year to year.

The plaice egg is pelagic, large, and transparent, with a homo-

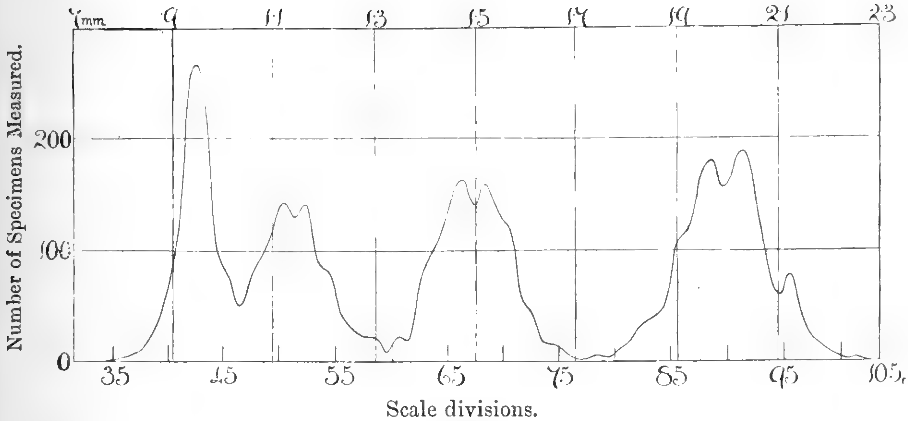

Fig. 1.—Eggs without oil-globules; diagram of size-frequencies (February 1905.)

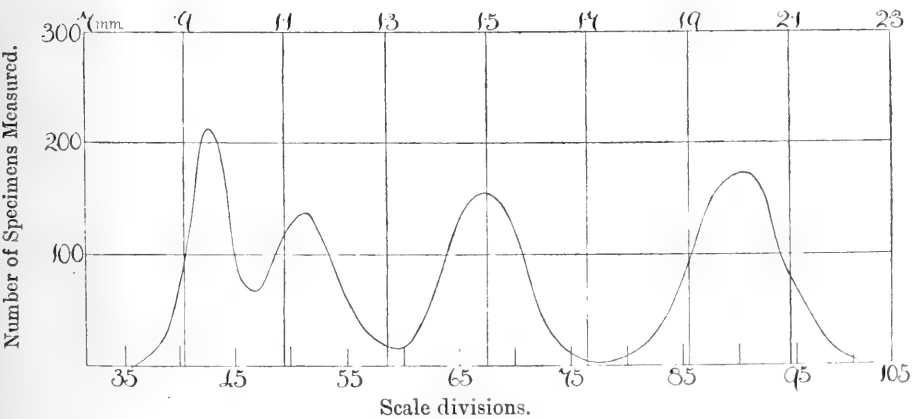

Fig. 2.—The same curve as in Fig. 1; smoothed.

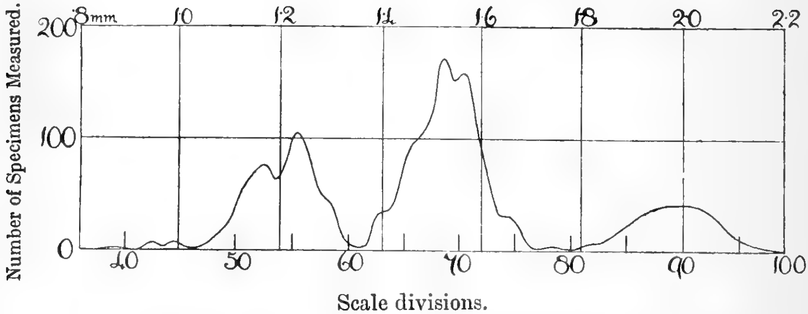

FIG. 3.—Eggs without oil-globule; size-frequencies (February 1907).

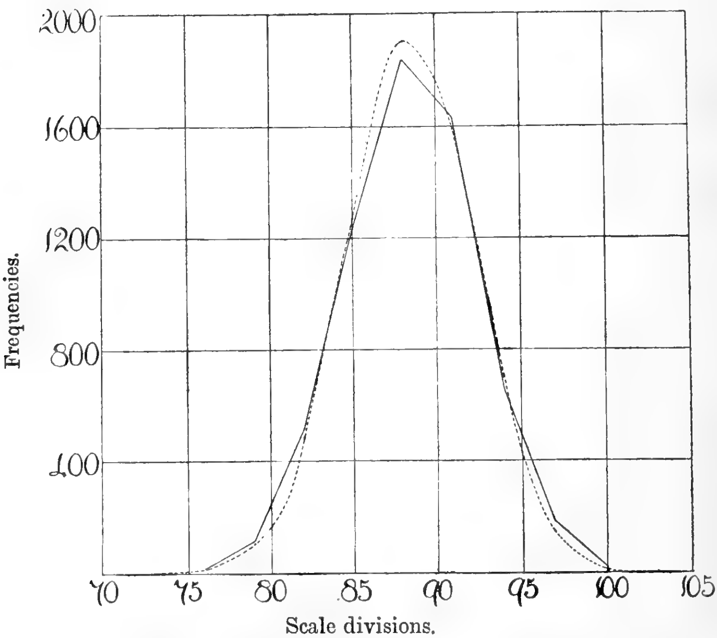

FIG. 4.—Variation in 6218 Plaice eggs—Dornoch Firth (February).
- - - - - Theoretical frequencies.
——— Observed frequencies.

geneous yolk and no oil-globule. The perivitelline space is relatively very small, whilst the thick capsule shows under the microscope a wrinkled appearance. The yolk becomes quite opaque when the egg is preserved, and it can be distinguished from other eggs only by its larger size and the corrugations on the capsule. The eggs of the plaice are amongst the largest found in the plankton, and in the present collections they form a group whose sizes are almost entirely beyond those of the other groups. As is seen in the examples already given for February, only a very small percentage of specimens at the lower limit of the range may overlap the other group. If the embryo is far advanced in development a separation may at once be made; and in addition the relative thickness of the capsule, the time and place of spawning are valuable aids to identification. Thus, the percentage of errors of identification is negligible.

It is unnecessary, in the present instance, to deal exhaustively with the question of the distribution of sizes of plaice eggs throughout the spawning period within the different Scottish areas, but one illustration is given for the month of February from the Dornoch Firth.

Variation in 6218 plaice eggs collected from the Dornoch Firth in February (the material preserved in $2\frac{1}{2}$ per cent. formalin over one year). (See Fig. 4).

Scale Divisions.	Theoretical Frequencies.	Observed Frequencies.
73	·577	—
76	11·464	15
79	103·647	118
82	486·253	514
85	1269·894	1241
88	1894·052	1840
91	1589·468	1632
94	705·417	660
97	145·526	182
100	10·886	16
103	·178	—
—	6217·362	6218

90 scale divisions—2 mm.
Mean—88·424089.
Standard Deviation—1·2759 (in units of measurement—3·8277).
Mode—88·616164.
P.—·02.

Although this represents a curve which approaches very closely to the Normal Curve, it is best described by a curve Type I. (Pearson). From similar material of 6218 eggs a worse fit would occur only once in fifty samples.

Heincke and Ehrenbaum (1899) point out a number of factors which may influence the mean diameter of the eggs of a species. There may be local races of the same species. The average diameter of the eggs depends largely on the salinity of the water in which they were spawned. The older and larger fish have larger eggs than the smaller and younger. The eggs are relatively larger at the beginning of the

spawning season, and on any particular area there is a gradual decrease in the mean size of the eggs of a species during the spawning season. The mean size of the egg differs at the different developmental stages ; when the embryo is almost ready to hatch there is a stretching of the egg-membrane and thus an increase in size. There are personal errors of measurement as well as errors of sampling. In spite of all such possible variations it is believed that these do not to any appreciable extent affect the identification of the plaice eggs here dealt with.

The most general survey of the distribution of the plaice eggs from November to March in the Northern North Sea is best got from the combined results of all the hauls taken within the ten years' period. The localities are at once divided into those in which plaice eggs were found and those from which none were recorded. The positive records are from the shallower areas, and the great bulk of the negative records occurs over the deeper parts. As a matter of fact, all the positive records are from within the fifty fathom contour line, and a closer study of the distribution shows clearly that the greatest frequency is within the thirty fathom contour line. It has to be remembered also that, in the case of a pelagic egg, such as that of the plaice, the spawning area is not necessarily coextensive with the distribution of the floating eggs. The general statement may, however, be made that the distribution of plaice eggs coincides very closely with the known distribution of the adults.

Spawning on the Scottish coast usually begins in the winter months and continues throughout the spring, while a small number of individuals may extend the spawning into the early summer. According to Ehrenbaum (1909) the spawning time for plaice in the North Sea extends from January to the middle of June, whilst in the Baltic spawning may begin as early as November and last till May. There is great difficulty in fixing absolutely the first date of spawning over such an extended area as the Scottish coast since visits to each locality must be comparatively infrequent. Even over such a prolonged period as ten years the difficulties are many, for one year may be more favourable than another for an early spawning.

The first records of the pelagic eggs may not coincide with the earliest date of spawning, for unless investigations are being continuously carried on in a particular area the first occurrence of the eggs may not be noted until some time has elapsed after their actual appearance. In the fertilised egg when first spawned there is no trace of an embryo, though very soon it assumes definite shape, and in the course of time surrounds the whole yolk. It is known that the rapidity of development of the embryo depends almost entirely on the temperature of the water, and the degree of development of the embryo thus gives some clue as to the time the egg was spawned. For the purpose of this investigation the eggs have been separated into four groups according to the degree of development of the contained embryo. It is not implied that these four stages divide the hatching period into equal intervals of time.

α.—The newly-hatched egg before there is any indication of form in the embryo.

β.—When the embryo has begun to assume a definite form but does not extend round half the diameter of the yolk.

γ.—When the embryo is more than half round the diameter of the yolk.

δ.—When the embryo is coiled completely round the egg, that is, just shortly before hatching.

As the eggs float passively in the water those in the first stages of development are not only nearer to the date of spawning but are more likely to be nearer to the actual spawning area than those which have passed into the later stages of development. In other words, the area of distribution of the eggs in the later stages of development is wider than the actual spawning area. A study of the distributions of the eggs in the various stages of development may therefore show not only the general effect of the currents on such passive objects but also the conditions under which the tiny larvæ are hatched out.

The extensive observations made by the "Goldseeker" during the month of November cover a considerable portion of the area within the fifty-fathom line, but no plaice eggs were found so early in the season. One may conclude with certainty that few, if any, plaice spawn in the Northern North Sea in November.

The first records of plaice eggs in the plankton of the "Goldseeker" collections occur in December. They were made at three different localities during the ten years, and they are of sufficient importance to be given in some detail.

Records of Plaice Eggs Collected during the Month of December.

Year.	Date.	Locality.	Total number of eggs examined.	Vertical Haul. 1 metre. ch. cl.	Horiz. Haul. ch. cl. at surface.	Stage in Development.			
						a	β	γ	δ
1904	19	57° 53′ N. 3° 20′ W.	126	..	3	120	6	..	..
	20	50° 57 N. 30° 20′ W.	4	..	4	..	..	4	..
	22	56° 16′ N. 2° 17′ W.	1	..	1	1	..	..	..
1908	1	57° 53′ N. 3° 48′ W.	2	..	..	2	..	..	..
1910	11	57° 53′ N. 3° 48′ W.	2	..	..	2	..	..	..

These are the earliest records for Scottish waters. Three are from the Dornoch Firth area (57° 53′ N.; 3° 48′ W.) and one is from East of May Island (56° 16′ N.; 2° 17′ W.). The Dornoch Firth area, which is one of the earliest and most important spawning areas of the plaice on the East Coast of Scotland, has been visited with great regularity during the last ten years, and the following tables shows how the

average date of the first appearance of the plankton eggs may be approximated.

BEGINNING OF SPAWNING SEASON IN DORNOCH FIRTH.

MONTH.	1904–1905.	1905–1906.	1906–1907.	1907–1908.	1908–1909.	1909–1910.	1910–1911.	1911–1912.	1912–1913.	1913.
November .	—	.	.	.	.	—	—	.	—	—
December	19th	19th	18th	..	1st	..	11th	..	..	8th & 9th
	+	—	—	.	+	.	+	.	.	—
January . .	+	.	.	+	.	.	.	+	.	..
February .	+	+	+	+	+	+	+	.	.	..
March . .	+	+	+	+	.	.	+	.	.	..

NOTE.—+ indicates occurrence of eggs in plankton.
— observations made, no eggs found.
. no observations made.

This table shows clearly that plaice begin to spawn before the last days in December or during the first days of January, and in exceptional years spawning has begun late in November or very early in December. It is clear that season 1908–1909 was a very early one.

It is possible to approximate fairly closely to the date of first spawning of this species by an examination of the degree of development of the reproductive organs of the adults within the area. It has to be added, however, that it is doubtful whether adults which are approaching maturity remain in the immediate locality to spawn. Dr. Fulton (1905) records spawning plaice from the Moray Firth towards the end of December 1903, a fact which fits the early records of the "Goldseeker." On the East Coast of Scotland the reproductive organs of adult plaice show the earliest signs of the approaching spawning season of those species which have pelagic eggs. Males are usually earlier than females. In November 1913 three males were found quite ripe, and motile spermatozoa were demonstrated by examination under the microscope. The following are the records :—

Dornoch Firth, 17th November 1913—Two ripe males, each 37 cms. long.

Station II., Firth of Forth, 25th November 1913—One ripe male, 37 cms. long.

The record from East of the May Island (56° 16′ N. ; 2° 17′ W.) consists of one egg obtained on the 22nd December 1904. This area has been visited very regularly in December, but as the frequency is always comparatively low even at the height of the spawning season, it is very difficult to say whether this area is actually as early as the Dornoch Firth.

The only other positive record made for this month was at Station 29 (57° 57′ N. ; 3° 20′ W.) on 20th December 1904. The two eggs found had already been some time spawned as the embryos had reached the "γ" stage, so that one must conclude from this evidence that spawning had begun in the Moray Firth area in 1904 some time before this date.

As continuous records for each locality over such a wide area are not available, the elucidation of the quantitative distribution of the newly spawned eggs is all the more difficult. Each locality, no doubt, has its own peculiarity in regard to the range of time and maximal

period of spawning. Thus the date at which any locality has been visited is important, though the results of a visit at an unfavourable time are no true index of the actual density of spawning within the area. Again, the most favoured spawning area one year may not be the most favoured in other years. As a first approximation to the density of spawning within an area the highest frequency got at any time in the locality has been taken as the index. Only those eggs in the initial stages of development need be considered since, as has been indicated, eggs in the later stages of development may not have had their origin within the area in which they are ultimately found.

Some standard of measurement must be adopted to compare the frequencies of one area with those in another area. In the present investigations the standard vertical Hensen egg-net has not been regularly used, but vertical hauls with a cheese-cloth net with a mouth of one metre in diameter have been taken at all the observation stations. This net, although not a standard one like the Hensen net, is nevertheless a most efficient instrument for the capture of pelagic fish eggs.

The greatest number of plaice eggs taken in a single vertical haul was seventeen, obtained off Lossiemouth on the 22nd March 1906. Although, comparatively speaking, the density of plaice eggs was very great on this occasion, the number seventeen compares very unfavourably with the numbers obtained from the quantitative egg-net collections in the Southern North Sea. The Dutch and German investigations show that in this region at numerous points between 51° 39′ N. and 53° N. over one hundred eggs per square meter were captured at different times between the middle of January and the middle of February. Indeed, the South-west corner of the North Sea has been proved to be the most important spawning area in the whole Southern North Sea for plaice, and the maximum number obtained at one time was 570 plaice eggs per square metre of surface water. In the Northern North Sea only three vertical hauls contained more than ten plaice eggs, and the majority of vertical hauls had either one plaice egg or none. As a spawning area for the plaice the Northern North Sea is, therefore, of quite minor importance as compared with the Southern portion. But although this is so it is still highly desirable to know which areas on the East of Scotland are the more favoured ones at the spawning period.

Another standard of comparison has therefore been adopted. The number of plaice eggs in a horizontal haul of one half-hour's duration with a one metre cheese-cloth net has been chosen as the easiest and apparently most consistent standard. Several anomalies arise through adopting this method, for it is difficult to so regulate the speed of a vessel when towing a small and fragile cheese-cloth net that, in a drag of given duration, a fixed volume of water may pass through the net. Again, the eggs may, or may not, be uniformly distributed both horizontally and vertically within an area. This point we shall return to later. The records of the surface nets, with all their imperfections, are, however, the only ones available. A table (II.) has been drawn up for January, February, and March for the ten years, which shows the greatest number of eggs taken at one time, the average number of eggs captured, and the number of hauls made at each locality. The greatest frequency was obtained in the Dornoch Firth on the 27th February 1906 at Station V., when 1319 plaice eggs were taken in a

single haul. This rich haul is closely followed by one from Lossiemouth, where 1294 eggs were captured on 22nd March 1906 in a similar haul of like duration. These two hauls are easily the richest for the whole period considered. The frequencies of several of the stations within the Moray Firth area come next, though a very long way behind. Outside the Moray Firth the figures are very poor, the only frequency over one hundred being obtained at Bressay (near Lerwick). At Tod Head, on the East of Scotland, 82 plaice eggs were obtained in the surface net in one half-hour—a result which compares very unfavourably with the richer Moray Firth grounds. But still poorer are the results got from the area immediately outside the Firth of Forth. Unfortunately, no observations were made in the region between this area and the Northumberland coast, otherwise they would help to link up the Scottish records with those from the Southern North Sea.

The general conclusions, as deduced from these tables are, (1) that the Northern North Sea is a spawning area of minor importance for plaice when compared with the Southern North Sea, and

(2) that within the Northern North Sea area the Moray Firth is by far the most favoured locality for plaice during the spawning season.

The method of tabulation just described gives only the comparative frequencies of plaice eggs within the different areas. An area of low frequency, however, may possibly be a spawning area, although the total number of individuals spawning within the area may be very small in comparison to the numbers found in the areas of highest frequency. Such low frequency might be due to the intensity of fishing within the area. The percentages of plaice eggs in the different stages of development at those localities where more than twenty eggs have been captured has been taken as a standard of comparison. Pelagic eggs in the initial stages of development belong to the near neighbourhood in which they are fished. On the other hand, eggs in the later stages of development may be of composite origin. They may have drifted from some considerable distance into the area in which they are fished, or they may have been spawned within the area some time previously. It is just for this reason that observations made early in the spawning season are of such vital importance in the determination of spawning grounds. Any table that can at present be made embodying the facts cannot be completely representative until all areas have been frequently investigated in the early months of spawning. At the one extreme of such a table there are those localities at which more than 80 per cent. of the eggs were in the initial stages of development, at the other extreme where all the eggs were in the later stages of development. The positions at which more than 80 per cent. of the eggs were newly spawned correspond very closely with the localities of greatest frequency. As the eggs advance in development there is a marked expansion in the area of distribution—a result which might have been anticipated. It seems as if the plaice spawn in comparatively restricted areas and the positions of the stations where the eggs occur with greatest frequency, and where the percentage of eggs in the "α" stage of development is high are all very near the coast well within the thirty fathom line. At Noss Head (Caithness) and Station 26 (58° 11′ N.; 0° 32′ W.) the depth is, however, over thirty fathoms. Noss Head Station is only three miles from the rapidly shelving coastline, whilst Station 26 is in the vicinity of a small shallow bank in the Moray Firth.

The general study of the distribution of plaice eggs shows that the area within which they occur is a well-defined one. This area in the northern part of the North Sea is bounded by a line which runs almost parallel and adjacent to the fifty fathom (or 100 metre) line; then parallel to the coast of Scotland from Rattray Head to the Firth of Forth, including practically all localities, a less depth than forty fathoms. For the purpose of description it is convenient to divide this region into the following sub-areas :—Moray Firth, outlying Moray Firth Stations, Shetland, Fair Isle and Orkney, East of Scotland (South of Moray Firth), Firth of Forth, Stations East of Firth of Forth, Minch.

PLAICE EGGS.

Dornoch Firth.

December–March 1904–1913.

Month.	Date.	Year.	Locality.	Haul. Vertical.	Haul. Surface half-hour	No. at *a* stage at surface.	Developmental Stages Percentages. α	β	γ	δ
December	19	1904	28	0	3	3	95·2	4·8	..	..
	1	1908	28	0	0	0	100	..	..	..
	11	1910	28	0	0	0	100	..	..	..
January	25	1905	28	1	267	264	96·05	1·47	1.75	·72
	11	1908	28	1	1832	1520	82·84	13·51	3·65	..
	8	1912	28	0	16	14	84·2	5·3	10·5	..
February	24	1905	28	4	74	42	65·2	13·00	15·02	6·2
	20	1906	28	2	37	30	81·6	16·6	1·7	..
			M. F. IV.	..	797	764	95·86	3·51	·62	..
	27		M. F. V.	..	1370	1319	96·27	1·4	2·19	·14
			M. F. VI.	..	397	362	91·18	6·04	2·78	..
	8	1907	28	3	24	18	58·66	34·66	2·67	4·0
	17	1908	28	1	598	560	94·11	3·22	2·64	..
	3	1909	28	13	388	304	78·78	15·53	5·13	·56
	4	1910	28	1	4	0	78·12	21·88	..	..
			28	0	124	104	82·98	8·86	8·16	..
	13	1911	M. F. IV.	0	3	2	66·7	33·3	..	..
			M. F. V.	..	44	41	95·35	4·65	..	..
March	31	1905	28	2	6	4	15·5	5·9	21·7	56·9
	22	1906	Dunrobin CastleN.N.-W. 3 miles	..	118	25	21·2	34·7	37·3	6·8
	7	1907	M. F. VI.	..	348	334	95·3	1·2	1·6	1·9
	25	1908	28	9	522	510	74·0	2·8	8·3	14·9
	8	1911	28	..	6	0	55·1	30·9	12·5	1·5

Note.—The percentages in the different developmental stages are calculated from the total number of eggs examined.

The Moray Firth Area.

(*a*) *The Dornoch Firth.*

It has been shown already that the Dornoch Firth is one of the most important spawning grounds for the plaice in the Northern North

Sea, and that here the earliest records of the occurrence and the greatest frequency of plaice eggs in the plankton were found. The details of the investigations made in this locality are given very fully in the accompanying table (p. 13). The table proves that the spawning season begins before the first days in January, and that in exceptionally early seasons it may begin a month earlier. Spawning is very general towards the end of January, and the maximum frequency obtained at any time within this area was reached on 11th January 1908 when 1832 eggs were taken in a surface haul of one half-hour's duration.

As has been stated, in the Northern North Sea the plaice is the species with pelagic eggs in which the reproductive organs in the adult first indicate the approach of the spawning season. It is also the species which spawns first in the Dornoch Firth, and the eggs of the plaice are the only pelagic ones which have been collected as early as December. In the month of January in the Dornoch Firth they constitute on the average over 95 per cent. of the total catch of pelagic eggs, while in February the percentages of plaice eggs in the total catches throughout the ten years ranged from 4 to 78. Other species with pelagic eggs begin to spawn in the locality in February, but with varying intensity from year to year in relation to the plaice.

The complete table for the Dornoch Firth area is complex because the material from the stations are not strictly comparable from year to year, and indeed only in one particular spawning season, namely, 1904–1905, are there records for each month.

The table of the averaged results for each month gives the best general idea of the conditions within the area.

Dornoch Firth—Plaice Eggs.

AVERAGED RESULTS.

Month.	Haul. One metre cheese-cloth.		Number of eggs at *a* stage.	Developmental Stages.			
	Vertical.	Horiz. half-hour.		α	β	γ	δ
10th December	0	1	1	95·4	4·6	..	..
15th January	1	705	599	93·4	3·8	2·2	·6
14th February	3	330	296	81·82	8·88	7·01	2·29
19th March	3·66	200	175	61·0	7·3	11·8	19·9

The greatest frequency occurs in January, and there is an orderly decline in February and March. Although there is a decrease in the relative abundance of eggs in the initial stages of development the absolute number obtained even in March is high. The Dornoch Firth is therefore a real spawning area from December to March, but the intensity of spawning which is greatest in January falls off in the succeeding months. It is problematical, however, whether the increase in the relative abundance of the eggs in the later stages of development in February and March is altogether due to the presence of eggs which

were spawned earlier in the same locality since there is a fall in the absolute density of the eggs even as early as February. Such facts show how difficult it is to map out the spawning areas of a species from the occurrence of eggs in all stages of development in the later half of the spawning season without an intimate knowledge of the influence of the currents on the earlier spawned eggs.

In the spawning season 1904 1905 similar observations were made in all four months, and the series gives very consistent results. Horizontal hauls of one half-hour's duration were taken with one metre cheese-cloth nets at the following depths : surface, 5 metres, 10 metres, mid-water, and bottom. In addition, horizontal hauls of one half-hour's duration were made with the Petersen Young Fish Trawl at the surface, mid-water, and bottom. The total numbers of eggs at the different stages of development obtained in these hauls for each month make excellent index numbers for a comparison of the relative densities from month to month.

Dornoch Firth—Spawning Season 1904–1905.

COMBINED RESULTS OF HORIZONTAL HAULS.

Month.	One metre cheese-cloth hauls, 0 m., 5 m., 10 m., mid-water and bottom.				Petersen Young Fish Trawl, surface, mid-water, bottom.				Developmental Stages Percentages.			
	α	β	γ	δ	α	β	γ	δ	α	β	γ	δ
December .	15	2	0	0	105	3	0	0	95·2	4·8	..	..
January .	1603	19	12	4	2455	40	55	23	96·05	1·47	1·75	·72
February .	208	53	74	60	1567	303	330	120	65·2	13·00	15·02	6·7
March .	14	2	4	1	55	25	96	260	15·5	5·9	21·7	56·9

The results for this single spawning season agree very closely with the averaged results of the area over the ten years' period. The frequency is highest in January and diminishes towards March, and this diminution is accompanied by a decline, both relative and absolute, in the number of eggs in the initial stages of development. This decline was very marked in the spawning season 1904–1905, thus showing that spawning had not only begun early that season but was also to close earlier than on an average season. If the later developmental stages be considered separately it is seen that the maximum frequencies of the "β" and "γ" stages occurred in February, whilst the maximum frequency of those eggs in the "δ" stage did not occur until March or afterwards. Although there are maxima for eggs in the later stages of development, the total numbers which are indices of their density are very far from those of the newly spawned eggs at maximum frequency. The spawning area of a species may be somewhat restricted for obvious reasons, but as pelagic eggs advance in development there is a progressive expansion in their area of distribution. Within the Dornoch Firth, however, a certain percentage of the eggs remain within the area during the whole course of their development.

The more complete table for the Dornoch Firth shows that even within a spawning area of limited extent, there are very marked variations in the frequencies of the eggs on the same day at points relatively near to each other. Surface collections which were taken on 27th February 1906 have frequencies of 797, 1370, and 397 respectively. The relative proportions of the eggs in the different stages of development are practically identical, so that in all probability these eggs had the same origin. The Dornoch Firth is a shallow inshore area, and it is probable that the tides, carrying the eggs backwards and forwards once in twelve hours within the area, may vitiate deductions from single observations.

In 1908 the locality was visited in January, February, and March. The frequencies for these months are very high in comparison with those found in spawning season 1904–1905. Probably spawning plaice were more numerous during the season 1907–1908 than during the season 1904–1905. The frequencies of newly spawned eggs are extremely high in February, and although there is a decline in March there are still many newly spawned eggs within the area. On the other hand, on 11th January 1908 almost twenty per cent. of the eggs had already passed beyond the first stages of development, so that it is reasonable to assume that spawning had already begun in the first days of December 1907.

So far the records of collections from the different water layers have not been considered in any detail, although the percentages of eggs at the different stages of development are taken from the total number of eggs captured at a particular station. The number of eggs got in the vertical nets is so small that the results cannot be used with any degree of accuracy to compare the frequencies of eggs in the different water layers. We are thus forced back on the records of the horizontal hauls taken with non-closing nets at different depths. The cheese-cloth nets used in the observations are attached at definite intervals to a vertical loaded line which is towed very slowly behind the ship. The net which fishes at the bottom is attached to the vertical line quite close to the weight, the other nets are attached at the required distances along the line. Such a series of nets takes some time both to shoot and to haul, and as the bottom net is put away first and hauled in last it is necessarily a longer time in the water than the surface net. If these nets fish not only when they are being towed but also when they are being hauled the frequencies obtained must be higher than those which would be got from closing nets. The nets are towed for the same length of time, so that the catches from the nets below the surface should theoretically be equal to a horizontal haul and two vertical hauls, one at shooting and one at hauling. That is to say, if the eggs are uniformly distributed throughout the different water layers the number of eggs from the bottom tow-net should not exceed the number got in the surface-haul by more than twice the number got in the vertical haul. If the following table be considered from this point of view, the eggs in the Dornoch Firth were somewhat uniformly distributed throughout the different water-layers in January 1905. There are only minor differences between the numbers captured at the different depths. The table also shows that the vertical distribution in January 1908 was obviously very unequal, for most of the eggs were found in the surface layers. It should be noted that the frequencies

in the mid-water and bottom nets are quite small, although these nets were hauled through the surface layers in which the eggs were very numerous. On the other hand, it would appear that the eggs were most abundant in the lower water layers in February 1907, 1908, and 1911.

PLAICE EGGS—DORNOCH FIRTH.

VERTICAL DISTRIBUTION.

	January.			February.							March.	
	1905	1908	1912	1905	1906	1907	1908	1909	1910	1911	1905	1908
Vertical . .	1	1	1	4	2	3	1	13	1	..	2	9
Surface . .	267	1832	16	74	37	24	598	388	4	124	6	522
5 Metres . .	366	..	..	36	92	..	..	..	..	..	4	..
10 Metres . .	..	..	..	120	..	..	..	..	..	..	5	..
Mid-Water .	338	44	..	99	73	34	1008	504	36	658	2	140
Bottom . .	316	46	22	66	62	86	436	524	22	664	4	236

(b) *Stations East of Tarbet Ness.*

Stations 28, 29, 30, 31, 32, 33, and 34 are fifteen miles apart, and lie in a straight line stretching east from Tarbet Ness. (*See* Table I.). Station 32 (58° 08′ N.; 2° 00′ W.) is the furthest east within the Moray Firth area, and is about 57 miles from Tarbet Ness. For the sake of continuity the two stations 33 and 34, which lie beyond the area, have been included. Station 34 (58° 17′ N.; 1° 03′ W.) is the most easterly point from Tarbet Ness at which plaice eggs have been taken within the period. The "Goldseeker" trawling stations, Moray Firth, VII. and XVI., also lie close to this line, Station VII. being between 28 and 29, Station XVI. between 31 and 32, and slightly to the north of the line. This line of stations therefore stretches from the area of greatest frequency in the Dornoch Firth to the outer limit of the distribution of plaice eggs.

Station VII., Moray Firth.

Although few collections were made at Station VII. there is sufficient evidence to show that plaice spawn in the neighbourhood. The average frequency of plaice eggs in surface hauls in February was 34 and in March 144. The numbers of newly spawned eggs in the surface collections in February and March are, however, 26 and 102. In other words the percentage (over 30) of eggs in the later stages of development was as high in February as in March. Thus there must have been an accession of newly spawned eggs to the locality in the later month. From the present evidence it seems probable that the time of maximum spawning activity in this locality is slightly later than in the Dornoch Firth.

In March 1906 the eggs were very uniformly distributed throughout the different water layers, so that the actual density is much greater than is represented by the surface haul alone.

Station 29.

The presence of two plaice eggs in the "γ" stage of development in the collections in December 1904 has already been commented on.

The only other observations at this station were made in the one spawning year, namely, 1904–1905.

Plaice eggs are the first pelagic ones to appear in the plankton; in January they constituted over 95 per cent., and the percentage had fallen to 30 in February. The relative frequencies of the eggs in the surface hauls for January, February, and March are 46, 32, and 758 respectively, while the numbers of these in the first stages of development are 28, 18, and 404. Just as at Station VII. the greatest frequency occurs in March, even although the percentage of eggs in which the embryo has passed through the first stages of development is almost as high in January as in March. As the collections for both the Dornoch Firth and Station 29 contain samples taken at corresponding times during the spawning season 1904–1905, the frequencies of the newly spawned eggs in the surface hauls may be compared directly.

Number of Newly-Spawned Eggs in Surface Net.

Month.	Dornoch Firth.	Station 29.
December 1904	3	0
January 1905	264	28
February 1905	42	18
March 1905	4	404

It is evident that spawning is later on these offshore grounds than in the Dornoch Firth. Further, it would appear that the area most favoured by plaice during the spawning season varies slightly from year to year.

Station 30.

As many observations were made at this station the records are much enhanced in value. Notwithstanding the visits in December in different years, no plaice eggs were taken in this month in the neighbourhood. Observations made in January 1905 and 1908 show how variable the conditions may be from year to year. In 1905, on the 26th of this month, one egg was taken in the surface net, and in 1908, as early as the 14th, 28 eggs were obtained, of which 26 were newly spawned. The difference in frequency is much more marked if the collections from the deeper water layers are compared.

		26th January 1905.					14th January 1908.				
Developmental Stages		α	β	γ	δ	Total.	α	β	γ	δ	Total.
Vertical Haul		0	0	0	0	0	0	0	0	0	0
Horizontal	0 m.	0	0	0	1	1	26	2	.	.	28
,,	5 m.	0	0	1	1	2	..	..	..	..	..
,,	10 m.	1	2	0	0	3	..	..	..	..	..
,,	20 m.	1	0	0	0	1	..	..	..	..	..
,,	28 m.	0	0	1	0	1	0	0	0	0	0
,,	56 m.	1	0	3	1	5	0	0	0	0	0

Plaice eggs were more uniformly distributed throughout the different water layers in 1905 than in 1908, for if the hauls from the deeper layers are to be taken as representing not only horizontal but also vertical hauls these must be taken for both series of experiments. The uniformity of the distribution of plaice eggs throughout the different water layers in 1905 is also well illustrated in the numbers taken in the Petersen Young Fish Trawl at the same station.

PETERSON YOUNG FISH TRAWL.—STATION 30.—
26th JANUARY 1905.

Stage of Development.	α	β	γ	δ	Total.
Surface Haul—one half-hour	1	1	16	4	21
Mid-water Haul—one half-hour	2	5	16	10	33
Bottom Haul—one half-hour	2	0	8	12	22

Although the numbers are small they are significant. In 1908, when the eggs were just recently spawned, they were all at the surface ; on the other hand, in 1905, when many of the eggs were far advanced in development, they are more equally distributed throughout the different water layers.

The number of eggs at the "α" stage of development obtained in January 1908 shows that plaice spawn as far as thirty miles eastward of Dornoch Firth.

For the month of February there are no fewer than seven separate observations showing considerable variation from year to year. In 1909 and 1911 no plaice eggs were taken in the surface nets, but on the 7th of February 1907 as many as 112 were obtained in a haul of one half-hour's duration, and 64 of these were newly spawned. On this date plaice eggs constituted 99 per cent. of the total eggs captured. The averaged results for this month are as follows :—

Vertical Haul.	Horizontal Haul. $\frac{1}{2}$ hour.		Developmental Stages. Per cent.				Total examined.
	Total	In "α" stage.	α	β	γ	δ	
2	25·6	10·1	35·6	23·2	29·2	12·0	379

With the exception of the year 1907, there was always a greater percentage of eggs in the later stages of development than was found in the Dornoch Firth or at Station 29 at the corresponding date. Although plaice spawn here in smaller numbers than nearer the shore, there is always in this month a relatively greater percentage of eggs in the later stages of development, and these have had their origin outside the locality.

This station was visited on 31st March 1905, and again on 7th March 1911, and the frequency of plaice eggs at the surface was eight on both occasions. In 1905, however, four of these even on the last day of the month were newly spawned, while in 1911, early in March, all the eggs

were in the later stages of development. If the collections in these two years from the deeper layers be compared there is a correlation in the vertical distribution of the eggs, similar to that which has already been noted for other localities, between the frequencies at the different depths and stages of development. In March 1911, when none of the 42 eggs examined were found in the initial stages of development, the greatest frequencies were found from the mid-water layers and the bottom. In March 1905, when over 20 per cent. of the 136 eggs captured showed no trace of the embryo having passed beyond the initial stages of development, the highest frequencies both in the cheese-cloth nets and the Petersen Young Fish Trawl were found in the surface layers.

Station 31.

During the spawning season of 1904–1905 this locality was visited in December, January, February, and March, and the frequencies of the plaice eggs at the surface were 0, 16, 12, and 12 respectively. The records of the stages of development of these eggs, although few in number, throw more light on the matter under discussion.

	Surface Hauls—one half-hour's duration.				
Developmental Stages.	α	β	γ	δ	Total.
December . . .	0	0	0	0	0
January . . .	0	0	2	14	16
February . . .	2	0	0	10	12
March . . .	8	2	2	0	12

Without these details one might very naturally conclude that plaice were spawning in the neighbourhood as early as January although the spawning time in the locality is much later. It is clear that the frequency of spawning plaice falls and the spawning time is later as we pass in an easterly direction from the Dornoch Firth.

Moray Firth Trawling Station XVI.

The results obtained from this station are now much more readily understood when compared with those from the localities lying nearer to the Dornoch Firth. On 13th January 1905, 63 eggs were obtained in the surface collections, and only 3 of these were newly spawned. The other 60 eggs must have had their origin in an earlier spawning area at some distance from the point at which they were found. On 10th February 1910, 1 egg in the "β" stage was taken in the surface haul, and on 20th March 1908 the 12 eggs taken had all passed into the later stages of development, but 2 eggs were got in the "α" stage in the mid-water haul.

Station 32.

This station lies on the outer boundary of the Moray Firth area, almost 57 miles east from Tarbet Ness. No plaice eggs were taken here in the months of December or January, and from four visits in the month of February in the years 1907, 1908, 1909, and 1910 respectively only two plaice eggs were obtained. These two were in the "α" stage, and were taken on the 7th February 1907. On 7th March 1911 two eggs at the "γ" stage represented the surface cheese-cloth collection

and five in the "γ" stage the surface collection of the Peterson Young Fish Trawl. This station is therefore not far from the outer limit of the distribution of spawning plaice.

Stations 33 *and* 34.

Station 33 (58° 3′ N.; 1° 32′ W.) and Station 34 (58° 17′ N.; 1° 03′ W.), are fifteen miles apart, and lie on the straight line east from Tarbet Ness, but outside the Moray Firth area. No plaice eggs were taken here on any occasion in the month of December. In the month of January eggs appeared at Station 33, and on 26th January 1905 four were taken in the Petersen Young Fish Trawl from the bottom layers. These eggs were all well advanced in development, and the embryo had reached the "γ" stage. By the month of February eggs had also appeared as far east as Station 34, and two in which the embryo was almost ready to hatch out were obtained in a cheese-cloth net at the bottom. A few eggs were also captured at Station 33 in this month in the lower water layers. The embryo was in the "β" stage in one of these, while the others were all more advanced in development.

In March surface hauls only were taken at Station 34, and four eggs were got, of which two were in the "γ" stage, that is in an earlier stage of development than those found the previous month in the same locality. At Station 33, however, on the last day of March 1905, eggs were got in the first stages of development. The number is not large, and is exceeded by that in the later stages of development.

Thus the conditions deduced from the records at these outer stations are in harmony with those found at the inner stations on this line.

Summarising the results of the observations made along the line east of Tarbet Ness for the months of December, January, February, and March, we reach the following conclusions:—

1. Plaice spawn along this line as far east as Station 33.
2. Spawning plaice occur in greatest numbers at the inner stations. The Dornoch Firth area is the principal spawning ground, but there may be a slight variation in the distance off-shore of the most favoured locality from year to year.
3. Plaice spawn earliest at the inner stations.
4. Spawning on these inner grounds may begin in favourable years as early as the last days of November.
5. The maximum time of spawning in the Dornoch Firth is about the middle of January. After this there is a steady decline in the intensity of spawning.
6. Plaice begin to spawn later, and the time of maximum spawning is also later in an easterly direction.
7. Newly spawned plaice eggs are the first to appear in the plankton of the Dornoch Firth area, and eggs in the later stages of development increase in relative abundance in the later months.
8. Eggs in the later stages of development are the first to appear in the plankton of the off-shore stations. They appear as early as December at Station 29, later at the stations further east. They do not appear before March at Station 34.

9. The eggs in the later stages of development are relatively most numerous in the deeper water layers.

(c) *Stations along the South Shore of the Moray Firth.*

Observations were made at a series of stations along the south shore of the Moray Firth from Nairn Bay to Kinnaird Head. The stations taken in order from west to east are :—Nairn Bay, Burghead, Lossiemouth, Trawling Station X. Moray Firth, Portknockie, Troup Head, and Kinnaird Head. All these were visited in March 1906, and a direct comparison can be made between the frequencies in the different surface hauls.

Surface cheese-cloth.	Burghead Bay. 21/3/06.	Lossie-mouth. S.S.W.3½m. 22/3/06.	Station X. M.F. 8/3/06.	Port-knockie. S.S.W.4 m. 22/3/06.	Troup. Hd. S.E. 22/3/06.	Kinnaird Deep. 22/3/06.
Total . .	20	2450	202	154	56	40
Number at "*a*" stage	6	1294	105	68	8	·2

The greatest frequency both in the number of eggs at the "*α*" stage (1294) and in the total number (2450) was found at Lossiemouth. It has been stated already that these frequencies are the second highest from any station on the Scottish Coast. There is a gradual fall in the frequencies of the eggs in the surface hauls from Lossiemouth eastwards towards Kinnaird Head, and there is a marked fall westwards at Burghead Bay. The conclusion based on this evidence is that plaice were spawning in numbers at Lossiemouth in March, and that the number of spawning plaice was less both in an easterly and westerly direction from that locality. This fall in the absolute density of the eggs in the "*α*" stage is correlated with a fall in their abundance relative to total number of plaice eggs obtained in the locality. The following table gives the total number of eggs taken at different depths and the percentage of these in the "*α*" stage :—

Haul.	Burghead.	Lossiemouth.	St. X.M.F.	Portknockie.	Troup Hd.	Kinnaird.
Vertical .	14	17	..	4	4	3
Surface .	20	2450	202	154	56	40
5 Metres .	206	360	..	194	86	50
10 Metres .	292	..	..	..	..	..
Midwater .	356	456	..	174	106	64
Bottom .	18	232	..	162	158	68
Percentage at "*a*" stage .	32·8	51·5	51·9	28·6	18·3	·9

The extreme limit is reached in the Kinnaird Deep, where the percentage of plaice eggs in the "*α*" stage is less than one. On the other hand, more than half the number of eggs taken at Lossiemouth and Station X., Moray Firth, were newly spawned. (Fig. 5.)

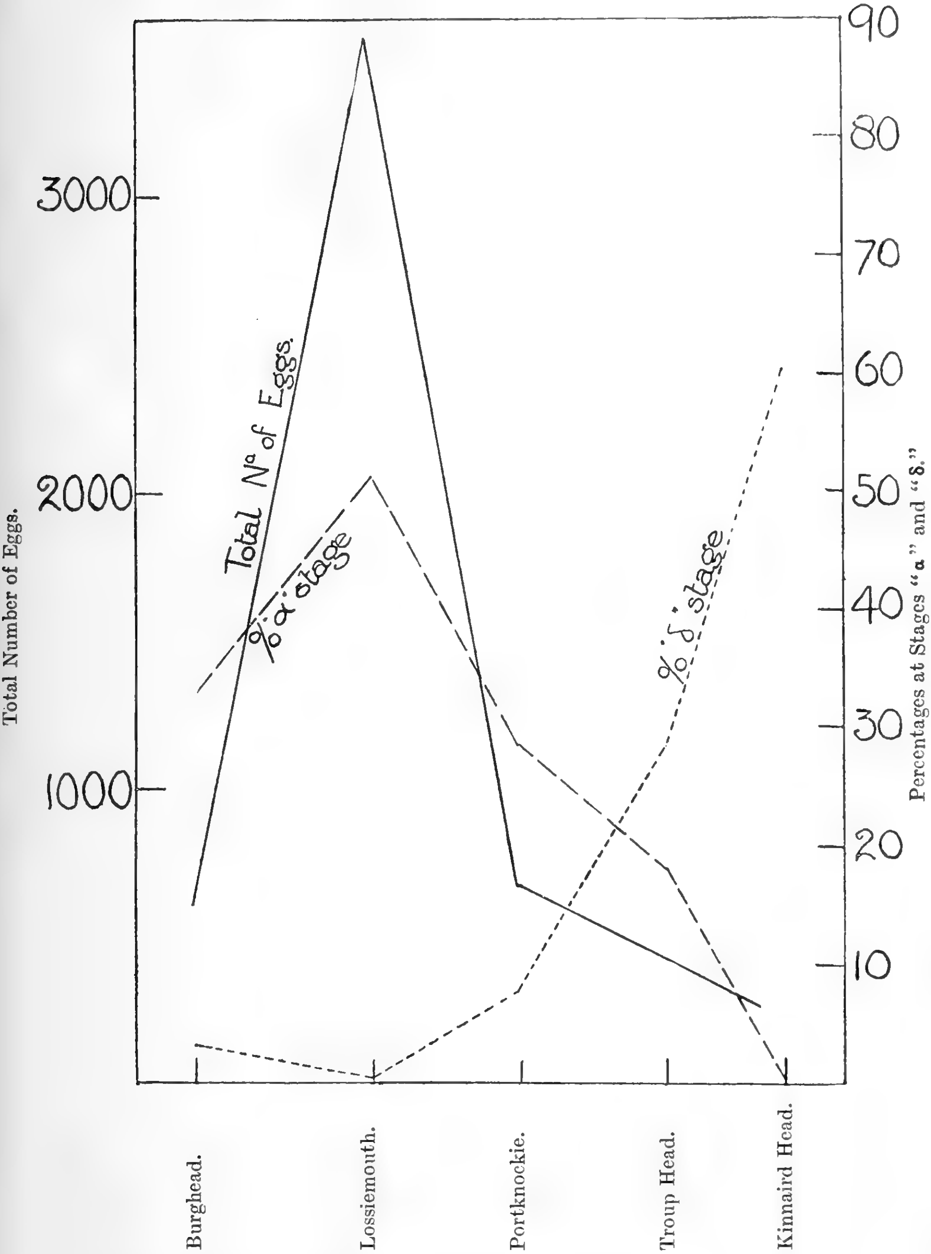

FIG. 5.—Relative abundance of Plaice Eggs at Stations on the south shore of the Moray Firth (March 1906).

The above table also shows that the higher the percentage of eggs in the later stages of development the more uniformly are they distributed throughout the different water layers. As the percentage for Station X., M. F. has been calculated from the surface haul only it may be too high. This station is, however, very close to Lossiemouth, where the percentage of eggs in the "α" stage in the surface haul only is 52·9. It appears that the area from Lossiemouth to Station X. was a very important spawning area for plaice in March 1906.

Two hypotheses may be assumed to account for the distribution of the eggs in the later stages of development. (1) Such eggs may belong to the area in which they are found. It would follow from this assumption that the spawning season off Kinnaird Head had begun somewhat earlier, and that the season was practically over in March; and, further, that the chief spawning time became later and later in a westerly direction to Lossiemouth. This deduction is contrary to the conditions found on the line east from Tarbet Ness. There it has been shown that the spawning time became later and later towards the east. (2) The eggs in the later stages of development may not belong to the area in which they were taken, but have drifted from some more or less distant spawning area. The results from both lines of stations are in agreement with this hypothesis.

Station X., Moray Firth, was again visited on the 26th March 1908, when 120 eggs, 90 (75 per cent.) in the "α" stage, were taken in the surface net. The newly spawned eggs were on this occasion relatively most numerous in the surface layers, and they totalled only 40 per cent. of all the plaice eggs taken at the station.

Observations were also made at Troup Head on 19th March 1908. The results agree with those for March 1906 at this locality. Ten eggs at the "α" stage of development were taken at the surface, and the newly spawned eggs constituted 37·5 per cent. of the total. The eggs in the later stages of development were relatively more numerous in the deeper water layers.

Burghead Bay.

Although the stations lying to the east of Lossiemouth have not been visited in the months of January and February, the Burghead area, which is not far distant from Lossiemouth in a westerly direction, has received special attention.

In this area there is considerable range in depth and in the character of the bottom within four miles of the shore. The deeper and gradually narrowing channel which runs into the Moray Firth ends in a finger-like process at a depth of thirty fathoms off Burghead. It is well known that the large plaice which congregate here in the winter months are found in great numbers neither in the very shallow water close to the shore nor in the deep muddy gut off-shore, but that they gather in considerable numbers in a very restricted area in the intermediate depths. It is not safe to assume, however, that all the adult plaice which are here in the winter months remain in the immediate vicinity for the purpose of spawning in the spring.

This interesting area was visited in December of 1907, and again in December 1912, for the purpose of making plankton collections, but on neither occasion were any plaice eggs obtained. It is unfortunate that

these years do not correspond with those in which plaice eggs were found in December in the Dornoch Firth. Indirect evidence led to the conclusion that plaice were spawning in the Dornoch Firth early in December 1907, and the negative results from Burghead in the same year may be due to later spawning in that area.

On 23rd January 1908 observations were made in this area in the shallow water, in the intermediate depths, and in the deep gully.

BURGHEAD—Plaice Eggs (vertical distribution).

Depth.	14 Metres.	23 Metres.	56 Metres.
Vertical Haul . .	0	1	1
Surface Haul . .	70	190	216
Mid-water Haul .	68	262	54
Bottom Haul . .	14	148	44

Plaice eggs are here most numerous apparently in the neighbourhood of the intermediate depths.

The frequencies, however, fall very far short of those obtained in the Dornoch Firth in the same month.

The percentages of eggs in the different stages of development obtained from the three observations are in such close agreement as to indicate they have all had the same origin.

Depth.	Percentages at Developmental Stages.			
	α	β	γ	δ
14 Metres . .	87·8	2·44	9·76	0
23 ,, . .	87·0	7·0	6·00	0
56 ,, . .	77·85	10·13	12·02	0

The high frequency of the eggs in the first stages of development suggests that plaice were then spawning in number in the locality.

The deeper the water the greater is the admixture in the collections of eggs of other species, the percentage of plaice eggs in the total catch from the shallow water outwards being 95·06, 81·35, and 80·61 respectively.

On 10th January 1912 no plaice eggs were taken in the plankton nets, although two days previously they were found in small numbers in the Dornoch Firth. Spawning had begun somewhat earlier than this date in the Dornoch Firth, so that the absence of place from the plankton in Burghead is probably due either to the lateness of the spawning season or to the small number of plaice in the area.

No direct comparison can be made between the January and February collections from this locality, as the February ones were taken in the years 1906 and 1910, and no observations were made in the month of January in those years. On 26th February 1906 fourteen eggs were taken in a haul of one half-hour's duration at the surface. On 3rd February 1910 there were only six eggs in the surface haul from the offshore ground, where the depth is 50 metres, and none in the surface haul from the shallower water about 15 metres deep. These February records are very poor, and in somewhat striking contrast to the comparatively rich hauls of January 1908. But the February 1906 collections from the Dornoch Firth were very rich in plaice eggs. These

additional facts undoubtedly support the view that the Dornoch Firth is a locality more favoured by the spawning plaice.

On 21st March fourteen eggs were obtained in a vertical haul, and twenty in a horizontal surface haul of one half-hour's duration, while on 24th March 1908 there were none in the vertical haul and 136 in the surface haul. This shows how careful one must be in regarding the number of eggs in the surface collections as an index of the absolute frequency of eggs in an area. The complete table of the hauls from the different depths gives the better view of the conditions.

	21st March 1906.					24th March 1908.				
Stages of development.	α	β	γ	δ	Total.	α	β	γ	δ	Total.
Vertical Haul .	2	6	6	0	14	0	0	0	0	0
Surface Haul . .	6	14	0	0	20	130	6	0	0	136
5 Metres Haul .	68	90	48	0	206	..	..	..	..	..
10 Metres Haul .	100	98	90	4	292	..	..	..	..	..
Mid-water Haul .	122	208	122	24	376	34	12	4	2	52
Bottom Haul . .	8	4	4	1	17	10	0	8	2	20
Percentages .	32·8	6·8	27·3	3·2	..	83·7	8·7	5·7	1·9	..

In 1906 the eggs were mainly distributed in the middle water layers, and in 1908 they were most numerous in the surface layers. Here the eggs in the later stages of development are relatively more numerous in the deeper water layers. The very variable salinities of water which do occur, however, in such coastal areas undoubtedly also influence the vertical distribution of pelagic eggs.

The distribution of the plaice eggs along the South Coast of the Moray Firth during the month of March 1906 has already been dealt with, but it is very unfortunate that the collections in January and February of that year are so meagre for this area. Burghead was visited in February 1906, and 14 eggs, 10 of which were in the "α" stage, were taken at the surface. This area, however, was visited in January 1908, and again in March of the same year. The results of the observations in January from the shallow water, the intermediate depths, and the deeper off-shore grounds have already been discussed. The averaged results got by combining the surface mid-water and bottom hauls from these three positions may therefore be compared directly with the 1908 results.

Burghead Bay (averaged results).

	α	β	γ	δ
January 1908. .	100·2	8·8	9·3	0
Per cent. . .	84·6	7·5	7·9	0
March 1908 . .	54·7	5·3	4·0	1·3
Per cent. . .	83·7	8·7	5·7	1·9

How are these results to be reconciled? The average number of eggs in the "α" stage of development indicates that plaice were spawning in the near neighbourhood from January to March, and that the spawning was probably more intensive in January than in March. But the fact that the relative number of eggs in the later stages of development is no greater in March than in January of the same year is proof that the eggs spawned earlier than March have already disappeared from this locality.

There are considerable differences from year to year within this

area. Thus, in contrast to 1908, plaice had not begun to spawn at Burghead in January of 1910, and even in February of that year newly spawned plaice eggs were very sparingly represented in the plankton nets.

On the other hand, the results obtained on 11th March 1907 agree very closely with those obtained on 21st March 1906, in regard to the stage of development of the eggs, although the vertical distribution varied considerably. The following are the percentages at the different stages of development :—

21st March 1906 .	32·8	6·8	27·3	3·2
11th March 1907 .	34·8	5·2	15·8	44·2

The conditions at this locality are apparently very complex and variable from year to year. It is probable that the observations have not been made with sufficient regularity in this area to enable us to give a satisfactory explanation of the complexities of the problem.

(d) *Stations VIII. and IX., Moray Firth.*

These are two of the "Goldseeker" trawling stations which lie in the intermediate zone between the two lines of stations just considered. The records of this area are therefore of value in helping to link up the results from these two lines of stations.

The north-west end of Station VIII. lies 12 miles E.S.E. from Tarbet Ness, and the trawling station extends S.E. for 3½ miles from this point to within 9 miles of Lossiemouth. Station IX. runs parallel to Station VIII. three miles to the east. These two stations are therefore situated over an area which lies in the triangle made by Station 29, Burghead and Lossiemouth, and have a depth of about 30 fathoms.

There is only one record from this intermediate locality in the month of January. Observations were made at the S.E. end of Station VIII., Moray Firth, on 23rd January 1908, and 4 eggs in the "α" stage were taken in a surface haul. A total of 22 eggs was, however, obtained from the different water layers, and only 8 of these were newly spawned. It has already been stated that in January 1908 very large numbers of newly spawned eggs were obtained in the Dornoch Firth and at Burghead Bay. At Station 30, also, a later spawning area than the Dornoch Firth, 26 of the 28 eggs captured were in the "α" stage of development in this month. Spawning plaice were very scarce in January 1908 on this area from ten to twelve miles off Lossiemouth. But whence came the relatively high proportion of eggs in the later stages of development? Eggs in the later stages of development were not found so far east as Station 32 in this month. It has already been proved that plaice were spawning earlier this season towards the Dornoch Firth and at Burghead Bay.

Station VIII., Moray Firth, was again visited in March 1908. The absolute number of eggs in the later stages of development had increased considerably, but so, too, had the number of newly spawned eggs, and relative to the numbers at other stages these were much more numerous. This area is therefore a spawning area which is later than either the Dornoch Firth or Burghead Bay.

Plaice were also spawning close to Lossiemouth in March 1908, probably in slightly greater numbers than at Station VIII. The relative proportions of eggs in the different stages of development are

somewhat similar at the two localities. Were these far advanced in development eggs derived from the same spawning area ?

Further observations were made at Station VIII. in March 1906, and Station IX was twice visited in the same month. The collections made at the N.W. ends of these trawling stations were comparatively rich in plaice eggs ; 110 newly spawned eggs were taken at the surface at Station VIII. on the 15th of the month, and 94 similar eggs at Station IX. on the 8th. The percentages of eggs in the different developmental stages were also very similar, as over 50 per cent. having the embryo well developed. The eggs of the 8th were, however, slightly in advance of those of the 15th. This condition is in agreement with what was found on other off-shore areas. The observations made on the S.E. end of Station IX. on the 15th give somewhat different results. Here only one newly spawned egg was taken in the surface haul, the other 103 eggs having the embryo quite distinct. This record confirms the statement that the narrow area about 9 to 12 miles off Lossiemouth is not frequented to any great extent by spawning plaice. It is also very clear that the eggs in the later stages of development in this area are not derived from the Lossiemouth area, for in this month plaice were spawning there in very large numbers.

Observations were again made at Station IX. on the 14th March 1907, and the results agree with those found in other years. The relatively higher percentage of eggs in the later stages of development may be due to the lateness of the spawning season in 1906–1907.

The general conclusions regarding Stations VIII. and IX., Moray Firth, are :

(*a*) This is a spawning area. Spawning is most intensive towards Station 29.
(*b*) Few, if any, plaice spawn in the deep water off Burghead and Lossiemouth.
(*c*) The time of maximum spawning is later than at Burghead or Dornoch.
(*d*) Numbers of eggs in the later stages of development are carried into this area from earlier spawning areas.
(*e*) These early spawned eggs are not derived from the spawning areas on the south shore of the Moray Firth.

(e) *Nairn Bay.*

Station II., Moray Firth, which is situated in Nairn Bay, was visited in February 1906, and five plaice eggs were obtained in a surface haul. This isolated observation is of small value.

(f) *Cromarty Firth.*

Although five plaice eggs were taken in a surface haul within the Cromarty Firth, it is not at all probable that plaice spawn there. Four of these eggs had the embryo well advanced, and in all probability they had drifted into the Firth. Extended observations within this area would be of considerable value as a means of adding to our knowledge, not only of the plaice species, but more especially of such species as the flounder and common dab.

One egg in the " γ " stage of development was taken in a surface haul on March 1907 in the Cromarty Firth, and in March 1908 one egg

in the "α" stage was found in the surface net at Sutors of Cromarty, N.W.N. $1\frac{1}{2}$ miles.

The few eggs found within the area were well advanced in development, so that plaice apparently do not spawn in the immediate vicinity of the Cromarty Firth.

(g) *Stations along the N.W. shore of the Moray Firth.*

Four stations along the north-western coast of the Moray Firth, namely, Sinclair Bay, Noss Head, Lybster, and Helmsdale were very thoroughly investigated on 21st March 1906. Vertical haul and horizontal hauls at surface 5 metres mid-water and bottom were made with the cheese-cloth nets at each locality. The relative frequencies of the eggs are compared by taking the total eggs captured in the horizontal hauls at each station. The following are the results :—

N.W. shore of Moray Firth.	Total eggs in horizontal hauls. 0 m. 5 m. mid-water, and bottom-hauls. Developmental Stages.					Total.
	α	β	γ	δ		
Sinclair Bay . . .	30	6	4	4	=	44
Noss Head . . .	298	8	4	2	=	312
Lybster . . .	16	8	2	2	=	28
Helmsdale . . .	92	54	76	4	=	226

At Lybster, which is situated half-way between Noss Head and Helmsdale, the number of plaice eggs in the "α" stage is insignificant in comparison with the number to the north and south. The Noss Head station is, however, of more importance than Helmsdale. The relations of these three stations are very complex. The high frequency of newly spawned eggs at Noss Head proves that it is an important spawning area. But if spawning had begun much earlier than March then all these earlier spawned eggs have been carried away from the locality. If the records from Lybster and Helmsdale are taken into consideration it does not seem likely that such eggs were carried along the coast to the south, the number of eggs advanced in development being so few at Lybster. Conversely, if Helmsdale is an earlier spawning area there is no drift along shore to the north. But the eggs in the later stages of development at Helmsdale may be derived from the south. Off Tarbet Ness on the 20th March 1906 the numbers obtained in hauls similar to those made at Helmsdale were :

	α	β	γ	δ
Tarbet Ness . . .	452	122	70	4

So, too, the number of eggs in the different stages of development taken at Station VIII., Moray Firth, on 15th March 1906, in a surface haul only, were :

	α	β	γ	δ
Station VIII., Moray Firth (surface haul) .	110	93	21	0

Although there is a slight rise in the relative proportion of the eggs in the later stages of development at Helmsdale this agrees very closely with those two stations towards the south.

The shallow water conditions in Sinclair Bay probably account for

the fall in frequency of the plaice eggs as compared with those at Noss Head.

(h) 58° 5′ N.; 3° 13′ W.

Plankton collections were taken 14 miles east of Helmsdale on 23rd March 1907, and no newly spawned eggs were found in the surface haul. We have already seen that spawning was late in other localities in season 1906–1907, and the absence of newly spawned eggs in this area may be due to this cause. The large number of eggs in later stages of development shows that this area is invaded by eggs from earlier spawning regions.

(k) *Berriedale.*

The frequency of plaice eggs was very low when collections were made off Berriedale on 7th February 1910. Newly spawned eggs, of which there were four, were all taken at the surface, and they make only 8·7 per cent. of all the plaice eggs collected on the station. This locality lies to the north of Tarbet Ness, where the frequency and the relative proportion of newly spawned eggs were much higher even two days previously.

The evidence, so far as it goes, seems to show that spawning is later from Tarbet Ness towards Helmsdale, and that there is a drift of some of the earlier spawned eggs in this direction.

(l) *Smith Bank.*

It is unfortunate that this locality, which has always been looked upon as a favourite spawning area for plaice, has only been visited once, namely, on 21st March 1906. A very large number of eggs was taken in the plankton nets on this occasion, but the results when compared with those of Noss Head for the same date show that plaice were not spawning in any number on Smith Bank, but that the most favoured locality was close to Noss Head.

	Total eggs in horizontal hauls from 0 m., 5 m., mid-water, and bottom. Developmental Stages.			
	α	β	γ	δ
Smith Bank . . .	10	274	370	8

Where have the large number of eggs in the later stages of development come from? Observations made at Station XVI., Moray Firth, which lies a few miles south of Smith Bank, may be helpful in this relation. At Station XVI., even as early as January, most of the eggs were in the later stages of development, and the same result was noted in March. Indeed, in the month of January, 60 of the 63 eggs captured had already passed through the initial stages of development. Now, it has been shown already that the neighbourhood of Station XVI. is a late spawning area, even although eggs in the later stages of development are the first to appear in the plankton in the area. There seems to be no doubt therefore that if Smith Bank is a spawning area it is a late one, and that before spawning begins within the area eggs in the later stages of development have already been carried into the locality from other and earlier spawning grounds.

Although mature plaice are present on Smith Bank during the early months of the year it does not necessarily follow that they spawn in large numbers in the immediate vicinity, for, as has been shown, most of the eggs obtained over the "Bank" are well advanced in development. The present investigation, though by no means final, seems rather to point to the conclusion that these mature plaice, when ready to spawn, migrate towards the coast at Noss Head.

II. Stations on the Outer Limit of the Moray Firth Area.

Stations 26, 33, 34, and 24 are situated outside the Moray Firth area either adjacent to or outside the 100 metre contour line of depth. The conditions at Stations 33 and 34 have already been considered in their relation to the line of stations which stretches eastwards from Tarbet Ness.

Station 26 (58° 09′ N.; 1° 50′ W.).

This station lying between Kinnaird Head and Station 32, but nearer to Station 32, has yielded some striking results. No plaice eggs were found in the plankton on the two occasions on which this locality was visited in January. Observations on 21st February 1905 and on 12th February 1907 both yielded positive results. In February 1905 the 12 eggs taken in the surface net were in the "α" stage, and in February 1907, 43 of the 45 eggs captured in the different water layers were also newly spawned. Thus these observations are quite different to those made in the corresponding period of the year at Station 32, a few miles to the north. The newly spawned eggs are the first to appear in the plankton in the vicinity of Station 26. Again, on 24th March 1910, 25 eggs were taken in the different water layers, all of which were newly spawned. There is no doubt therefore that a few plaice spawn close to this area in February and March, and as no eggs were taken in January the beginning of the spawning period is later than at the inner stations in the Moray Firth.

On 11th March 1908 two eggs in which the embryo was just ready to hatch were captured in the bottom tow-nets. These eggs may belong to the vicinity, but they are more probably derived from the same earlier spawning areas as those which appear at Stations 32, 33, and 34.

The probable explanation of the anomalous records from this locality is the proximity of a few shallow banks of limited extent. These shallows are known to trawling masters as Boseys Bank.

Notwithstanding repeated visits to localities east of the Moray Firth area, no plaice eggs have been taken over the deep water in the plankton before April.

Station 2 (58° 36″ N.; 1° 46′ W.).

Station 2 is situated outside the north-eastern border of the Moray Firth, near the 100 metre line. Observations made in the different months are very variable. No plaice eggs were found in the locality before the month of February, nor were any found on 17th February 1909 or on 11th March 1908.

On 22nd February 1905, however, 10 plaice eggs were taken in a surface haul, of which 8 were in the "α" stage. On 12th February 1907, 2 only of the 42 eggs captured in the different water layers were newly spawned, and in 25th March 1910 the 16 eggs taken were in the "α" stage of development.

These positive records show that although plaice spawn in the near neighbourhood they are few in number; otherwise the maximum spawning period is very late. But Station 2 is close to the boundary line which marks the extreme limit of distribution of the adult plaice.

III. Stations in the Neighbourhood of Orkney.

Although observations from this area are confined mainly to the month of March, the results are of significance when compared with those from the Moray Firth area lying immediately to the south. At the Pentland Skerries on 12th March 1908 observations were made with cheese-cloth nets, and in addition a series of six hauls was taken with the Petersen Young Fish Trawl. The total of 16 eggs obtained in all these hauls indicates the low frequency of plaice eggs in this locality in the first half of March. Again, on 16th March 1908, the young fish trawl was operated for ten hours at the surface in the Pentland Firth when only 72 plaice eggs were collected. The frequencies and degree of development of the eggs from these two positions agree very closely.

Observations were made somewhat further to the west at Dunnet Head on 8th March 1913, and 46 eggs were taken in surface, mid-water, and bottom cheese-cloth tow-nets. The frequency of the eggs was therefore considerably higher here, and a greater percentage of them were in the earlier stages of development. Although the observations were made in different years there is an indication here that spawning plaice are perhaps more numerous to the westward on the North Coast of Scotland at this time of the year.

On 8th March 1913 twelve plaice eggs in the "α" stage of development were captured from the different water layers at Auskerry Light, W./N. ½ N. 6 miles. None were got in the later stages of development at this locality on that date.

Station 3 (59° 10′ N.; 1° 27′ W.).

This station is situated about 35 miles east of Auskerry Light, close to the 100 metre line. No plaice eggs were found in the plankton of this locality at any time in January. Though none were found on 17th February 1909, on 2nd February 1905 two freshly spawned plaice eggs were captured at the surface, and again on 13th February 1907, six in the early stages were taken at the surface, but none in the lower water layers.

On 12th March 1908 three newly spawned eggs were taken in a vertical haul, and on 23rd March 1910 the four eggs captured were in the bottom tow-net and in the initial stages of development.

Thus eggs taken on this station were always few in number, and all in the initial stages of development. We have already seen that similar results obtain nearer the East Coast of Orkney. The conclusion seems to be that in this large area to the east of Orkney plaice spawn in very small numbers in the first quarter of the year, and that spawning seldom

begins before February. It has to be noted that no plaice eggs were obtained in the later stages of development in March, although spawning had already begun in February.

Dr. Fulton (1913), in a study of the seasonal distribution of adult plaice, concludes that in this area (Statistical Area XIII.) there is an accumulation of fish during the months of spawning and a diminished abundance in the latter part of the year. The conclusions from the occurrence of plaice eggs in the plankton in the first quarter of the year are either that the west side of Orkney is the earlier spawning locality or that there are fewer adult plaice on the east side at this period.

IV. Fair Isle and Neighbourhood.

Stations 4 (59° 26′ N.; 1° 20′ W.) and 5 (59° 40′ N.; 1° 14′ W.), which lie close to Fair Isle, have been visited frequently within the period under observation, but on no occasion were plaice eggs found in large numbers.

At Station 4 no plaice eggs were obtained in the month of January or in February of 1907 and of 1909; neither were any taken in March of three different years. Only on 22nd February 1905 were two plaice eggs in the "α" stage of development got in the surface haul.

Plaice eggs were taken in greater numbers at Station 5, although on two occasions in March, namely, on 25th March 1910 and 15th March 1913, experiments made in the different water layers gave negative results. Curiously enough, however, each of the four visits in February yielded positive results. On 2nd February 1906 and 17th February 1909 few, all newly spawned eggs, were found, but on 22nd February only 18 of the 36 eggs captured were in the "α" stage of development.

Again, on 12th March 1908 all of the 53 eggs captured at this station had passed through the initial stages of development.

Thus the records of these two stations do not indicate that plaice spawn in numbers in the vicinity of Fair Isle in the first quarter of the year.

Station 22 (59° 36′ N.; 0° 41′ W.).

This is rather an exceptional station, which has yielded negative results on all the occasions on which it has been visited in February and March, except on 22nd February 1905. On this date ten eggs were got in the surface net, and four of these were in the "α" stage of development. It should be noted, however, that in February 1905 plaice eggs were best represented at Stations 4 and 5, which lie to the west of this position. Station 22 is the most easterly point at which plaice eggs in the initial stages of development have been taken, for notwithstanding repeated visits to Station 23 (59° 31′ N.; 0° 37′ W.) no records have ever been found by the "Goldseeker." The statistical records of the large plaice show that the adults are caught in relatively small numbers, and mainly in the summer months, in this area (Statistical Area XIV).

Thus the area cannot be considered an important spawning ground for plaice in the first quarter of the year. The exceptional appearance of plaice eggs as far east as Station 22 may be due to the strong tides which are prevalent in this locality.

V. The Shetland Area.

The fifty fathom contour line of depth is very close to the East Coast of Shetland, so that there is only a very narrow zone of shallow water in the neighbourhood of the islands. With two exceptions, to be mentioned immediately, the stations which are in that area of over fifty fathoms in the Northern North Sea to the east of Shetland have never yielded positive results for plaice eggs. A few plaice eggs have, however, been captured at stations 5A (60° 05′ N.; 0° 48′ W.) and 5B (60° 37′ N.; 0° 35′ W.), which are situated just beyond the fifty fathom contour line on the east of Shetland. These stations have been visited with regularity but have always given poor results. No plaice eggs were found on any of the February visits, and the largest numbers of eggs captured in the first quarter of the year were got towards the end of March 1910.

	Number at Developmental Stages.			
	α	β	γ	δ
Station 5A—25th March 1910 .	20	11	8	2
Station 5B—25th March 1910 .	4	4	6	4

In March 1905 observations were made at a number of stations in the shelter of the islands and close to the coast in the shallower zone. At the inner stations within Yell Sound no plaice eggs were found, but at the north entrance to that Sound, just outside the Ramna Stacks, a few were recorded. Similarly, just outside the eastern entrance to Yell Sound, near Outskerry Light, they were but sparingly represented. At both these localities the eggs were well advanced in development. Plaice eggs were not found in Lerwick Harbour, but immediately outside at Bressay Light they occurred in relatively large numbers. A total of 68, of which 51 were in the first stages of development, was got in a half-hour haul at the surface with the cheese-cloth net.

"The Shetland Islands are included in Statistical Area X., and the smoothed monthly means of large plaice captured within this area show that there is an accumulation of adult plaice during the months which comprise the spawning period, and mainly in March and February" Fulton (1913, p. 125).

Thus we conclude that although plaice spawn on the East Coast of Shetland, spawning is confined to a very narrow belt close to the shore, and even to certain localities within this belt.

Stations Situated on a Line East from the Firth of Forth.

Station 46 (56° 16′ N.; 2° 17′ W.) is situated within the Firth of Forth, close to the Fife Coast, and Stations 45, 44, 43, and 42 are successively 15 miles apart to the eastwards of this position.

Two of the "Goldseeker" trawling stations within the Firth of Forth area may be considered along with Station 46. Station VI. ("The Fluke Hole") runs parallel to the Fife Coast, whilst Station V. lies west of May Island.

The area close to the Fife Coast within the Firth of Forth area has been examined with great regularity so that our knowledge of this area is fairly complete. Plaice do not appear to spawn here in December or January, as no plaice eggs have been taken in the locality, notwith-

standing the many observations made in these two months. Only on one occasion, namely, on 28th February 1905, although attempts were made in eight different years, were any plaice eggs (and then only three) found in the Petersen Young Fish Trawl. It is not until March that plaice eggs occur in any number in this locality. The highest frequency observed was in March 1909; and it was not until towards the latter part of the month that they appeared in any number. The following are the totals obtained in this locality in March 1909.

	Number at different Developmental Stages.			
	α	β	γ	δ
Station 46—5th March . . .	4	2	10	0
Station VI. (West end)—27th March	38	20	133	26
Station VI. (East end)—27th March	20	8	50	12
Station V.—26th March . .	12	7	40	18

One may conclude from the above data that a few plaice may spawn towards the outer limit of the estuary late in March. The eggs collected on the 26th and 27th of March 1909 at Stations V. and VI. probably have had a similar origin, the percentages at the different developmental stages being very much alike.

On 24th March 1911 observations were made at Station VI. in the different water layers, but only one egg in the "α" stage was got in a bottom tow-net, whilst on the same date no eggs were found at Station V. Other observations in this locality in the month of March have also given equally poor results, but when any plaice eggs occur the frequencies are generally higher at Station VI. than at Station V.

The absence of eggs from the area in February, and the large number in the later stages of development got in March, indicate that the locality, although a late spawning one for a few plaice, receives eggs from earlier spawning areas.

Station 45 (56° 16′ N.; 2° 17′ W.) *and Stations VIII. and IX, Firth of Forth.*

These stations are situated outside the Firth of Forth area; Station 45 lying about ten miles due east of May Island; Stations VIII. and IX. somewhat closer to that island, but a little to the south.

On 22nd December 1904 one plaice egg in the "α" stage of development was taken in a surface haul at Station 45. The record is a very early one, especially when compared with the conditions at Station 46. But on 31st January 1905, that is in the same spawning year, no plaice eggs were found at Station 45, although horizontal hauls were taken at the surface at depths of 5 metres, 10 metres, 20 metres, and at midwater and bottom. Very few plaice, if any, could have spawned in this area before that date. One plaice egg was got in a bottom haul with the Petersen Young Fish Trawl on 5th January 1905 a mile east of the May Island. On 15th January 1906 only one egg, in a tow-net ten metres below the surface, was got at Station 45, while 27 eggs all in the earlier stages of development were taken in the different water layers at Station IX. on 25th January 1911.

Thus, although spawning may begin early in this area, the frequency of plaice eggs in the plankton in January is very low.

There is a marked increase in the frequencies of plaice eggs in the month of February, but throughout the period under review spawning seems to have been most intensive in February 1905. Eighty-eight eggs, of which 81 were newly spawned, were captured on the 28th of this month. On 17th February 1906 the frequency of the eggs was almost as high, and over 90 per cent. were newly spawned. Fewer eggs were found on the February visits in the other years, and in 1908 none were present in the plankton collections. A very high percentage of the eggs caught in this locality in February were in the initial stages of development.

Our knowledge concerning the conditions within this area in March is derived from observations made at Stations VIII. and IX. The total number of eggs found on any occasion was small, but it is perhaps of more significance that the proportion of those in the later stages of development has not increased greatly. The following table gives the percentages of eggs at the different developmental stages in the four months in this area :—

	α	β	γ	δ
December . .	100·0	..	..	..
January . .	86·2	13·8	..	..
February . .	90·6	3·5	5·9	..
March . .	81·4	9·3	9·3	..

Station 44 (56° 20′ N. ; 1° 49′ W.).

Numerous observations have been made at this locality, but they have unfortunately been confined to the months of December and February. The December records give negative results for plaice eggs, and even in February the frequency is extremely low. In February 1908 no plaice eggs were found on the 13th of the month, and on the 23rd February 1910 one only was taken. The greatest number occurred on the 5th of February 1907, when only two of the eighteen eggs from the different water layers were in the " α " stage of development. If the separate records for the month of February are combined it is found that only a small percentage of the eggs is in the intial stages development. These records may be contrasted with those obtained at Station 45 in February.

Percentages at the developmental stages in February :

	α	β	γ	δ
Station 45 . .	90·6	3·5	5·9	..
Station 44 . .	26·2	45·2	28·6	..

This phenomenon is somewhat similar to that found on the line of stations which stretches east from Tarbet Ness in the Moray Firth, so that it would appear as if spawning was later the further east from the May Island. This hypothesis is further strengthened by observations which were made at 56° 17′ N. ; 1° 58′ W. on 7th March 1912. On this date 113 eggs were captured in that vicinity, and 111 of these were newly spawned. The frequencies obtained are much greater than any obtained at an earlier date, so that it would appear as if the maximum spawning period within this area does not occur before March. The area between Stations 45 and 44 must be regarded as a real spawn-

ing area for plaice, but it is evident from the figures obtained that it falls in importance very far short of the Moray Firth area.

Station 48 (56° 24′ N.; 1° 21′ W.) *and Station* 42 (56° 28′ N.; 0° 53′ W.).

A large number of observations has been made at these stations in December and February, but none in the months of January or March. No plaice eggs were found in any of the December collections, and the few which have been found in February show that in this area either spawning begins very late or few plaice actually spawn within the area. It has to be remarked, however, that only on two of the five occasions on which Station 43 was visited in February were any plaice eggs found. The total number of eggs from the different water layers was seven, and they were all in the "γ" stage of development. It can thus be asserted that for this station plaice eggs in later stages of development appear in the plankton before any newly spawned eggs are found. It is therefore certain that these older eggs are derived from an earlier spawning area. Plaice eggs were found at Station 42 on three of the five occasions on which it was visited in February. Here also eggs in the later stages of development appear early in the plankton, but on 17th February 1906 a high percentage of the eggs captured was newly spawned, so that plaice also spawn as far east as this station.

Stations 43 and 42 lie in the southern portion of Statistical Area XXIX. In this area the great feature regarding the abundance of adult plaice is their sudden increase, which lasts for three or four months (January to April), coinciding with the spawning season. Large plaice, however, are scarce on these grounds.

VI. Firth of Forth.

The "Goldseeker" trawling stations in the Firth of Forth area may be divided into an inner and an outer group. The outer group (Stations V., VI., VIII., and IX.) where the water is deeper we have already dealt with. There now remain the stations of the shallower portions of the estuary. Stations I., II., III., and IV. are well within the Firth, east of the Island of Inchkeith, while Station VII. runs between the Bass Rock and the Island of Fidra.

It would be tedious to enumerate the various observations made at these separate stations during the period under review. They have been visited many times in each month, and only on two occasions did the total number of plaice eggs captured in the different water layers exceed ten; on 4th March 1909 twelve eggs were taken at Station II., and on 26th March 1909 twenty eggs were taken at Station VII. No plaice eggs were taken at any of these stations before March, although numerous observations were made in the other months. Indeed, many of the observations in March gave negative results, and on all occasions the frequencies were very low. The total number of plaice eggs in all the March collections is sixty-nine, and the stages of development are as follows:

α	β	γ	δ		
22	10	31	6	—	69

These figures clearly indicate that the inner and shallower portions of the estuary play no part as a spawning area for plaice during these

months. Further, these figures show by the absence of plaice eggs in February, and the presence of a large percentage of eggs in the later stages of development, that the inner Firth of Forth derives some of its plaice stock from areas nearer the open sea.

Professor Thompson tells us that Carnoustie and St. Andrews represent a characteristic region, where a younger class of fish resides ; at the Firth of Forth Stations we have older fish, not markedly segregated on this or that station according to age, but with a greater and greater admixture of older fish as we pass to the outward and deeper waters.

" Again, the middle half (or 50 per cent. zone) of the plaice in the shallower estuarine bays is a quite separate lot of fish, not overlapping but wholly inferior in size (and age) to the similar middle block of the fish in the deeper waters at the mouth of the Firth of Forth.

" Further, in all the Firth of Forth Stations except one (Station IV.) the lower decile is over 25 cms. ; in other words, that well over 90 per cent. of the fish caught are above the size which it has been proposed to protect by a legalised ' size-limit.'

" In regard to the seasonal distribution of plaice in the Firth of Forth," he says " that if we examine the mean of all the stations, we see that the maximum catches are between July and September, and that the smallest catches, only one-fourth or one-fifth as great, are from January to March. At all stations the maximum lies either in the second or third quarter of the year, and in most cases in the third. It occurs in the second, or April–June quarter in the case of Stations II, IV., and VII. ; and these are the three shallow-water stations, in the bays on the north and south sides of the Firth. The season of minimum is not quite so regular, and, on these stations where the catch is small, is not so well defined ; but usually (on Stations I., II., V., VI., VII., and IX.) it falls in the first quarter of the year."

I have quoted these statements because, taken together with these records of the distribution of the eggs of plaice, they epitomise the life-history of this species in the Firth of Forth very succinctly.

Plaice spawn at the outer reaches of the estuary especially in the neighbourhood of the Fife Coast and east of the May Island. Some years are more favourable for spawning than others. Spawning begins somewhat earlier to the east of the May Island than on the Fife Coast. Those localities are only relatively of importance when compared with neighbouring localities, and fall very far short of such an area as that of the Dornoch Firth. Pelagic plaice eggs are always rare over the inner and shallower waters of the Firth of Forth, and eggs in the later stages of development appear in the plankton as early as the newly spawned eggs. Thus only sporadic plaice appear to spawn in the inner waters of the estuary, although plaice eggs may be derived from the outer area.

The percentage of very small plaice in the Firth of Forth is very small even at the inner and shallower stations. Accordingly only a very small stock of the O-group of plaice can be added yearly from eggs spawned outside the Firth. There is no evidence at present as to whether the stock of plaice belonging to the older age groups within the Firth are derived entirely from this O-group, or whether the stock is augmented by the immigration of immature plaice from the outer areas. Extremely few plaice of adult size are found in the inner waters

and shallower bays of the estuary, and in the first quarter of the year (that is, the spawning period) their number has reached a minimum.

There is an orderly increase in the number of adult sized plaice towards the mouth of the estuary and beyond. Even at these outer stations they reach their minimum in the first quarter of the year.

"There is an orderly migration out of the Firth of the plaice as they approach maturity" (Fulton).

VII. The East Coast of Scotland, South of the Moray Firth.

It has been stated already that the distribution of plaice eggs on the East Coast of Scotland in the first quarter of the year is limited by the fifty fathom line. Many observations have been made in the Northern North Sea in that large area of over fifty fathoms in depth, which extends from 58° N. latitude northwards to 61° 30′ on the edge of the continental shelf. Over this extensive area on no occasion have plaice eggs been captured in the first quarter of the year. This deep area of over fifty fathoms extends southwards as far as 56° N. latitude, and forms the "Gut" lying between 0° and 2° E. longitude. This narrow valley lies between the shallow coastal area of the East of Scotland, south of the Moray Firth, and the shallow zone of the Fisher Bank region where plaice are captured in number. Notwithstanding repeated observations over the deep valley in the first quarter of the year, no plaice eggs have been taken, although large numbers of pelagic eggs of other species, which are known to appear in the plankton later than the plaice eggs, have been found. These negative results are of significance, and they are confirmed by the negative results obtained by other methods. The analysis of the statistical data of the market catches shows that large plaice are absent from these grounds during the spawning months, although they may be caught there in relatively small numbers at other periods of the year.

Thus the distribution of the newly spawned eggs of plaice on the East Coast of Scotland is somewhat sharply defined in an easterly direction. A number of observations made within this area in the neighbourhood of the fifty-fathom line has given very poor results, but they indicate that most of the spawning plaice on the East Coast of Scotland are confined to the shallower water nearer the coast.

Not only are large plaice and newly spawned eggs absent from the area over the deeper water, but they are also absent from the extremely shallow coastal area. Spawning plaice are not found in the shallow sandy bays, and newly spawned eggs appear in proximity to the coast only where there is a rapidly shelving coast line.

No plaice eggs have been recorded in the various hauls made in St. Andrews Bay, Carnoustie Bay, and Lunan Bay. Very near to the shore in the shallow water at Tod Head and Red Head plaice eggs were also absent. But at Tod Head, offshore in the deeper water, 40 eggs, of which 24 were in the early stages of development, were taken in the different water layers on 27th February 1907. Also on 27th February 1907, $1\frac{1}{2}$ miles east of Cove, 94 eggs were captured at surface, mid-water, and bottom, but of these only 2 were newly spawned.

Off Collieston, on 14th March 1906, a surface net, in a haul of one half-hour's duration, captured 20 eggs, but only 2 of these were in the initial stages of development.

Near Cruden, on 3rd February 1908, only one egg was got from hauls made in the different water layers, and it had already passed into the "γ" stage.

Observations made in March at Rattray Head and Buchan Ness with a four-inch fine silk net gave positive results.

These observations are in full agreement with the results obtained by previous workers. For example, the conditions obtaining in the neighbourhood of St. Andrews Bay have been summarised by Professor M'Intosh (S.F.B.R. xii.). "Few or no spawning plaice (none within our experience) are ever captured within the Bay (St. Andrews), though eggs and young in various stages are not uncommon. It is stated that adult ripe plaice were formerly procured by hook and line off the rocky shore towards the mouth of the Bay, between Boarhills and Fife Ness, on hard ground on which no trawl could work. The adult spawning plaice in greater numbers occur in the off-shore waters, and, so far as is known, there is no passage of these from the outer to the inner area for the purpose of discharging their eggs—as was formerly believed in regard to many fishes."

Station 27 (57° 30′ N.; 1° 19′ W.).

This station is situated within the narrow finger-like valley made by the fifty-fathom line off Buchan Ness. From our knowledge of the general distribution of plaice eggs one might conclude that they should be rare or even absent in this neighbourhood. The records for this narrow valley between the shallower banks of the East of Scotland are very irregular, but never at any time were there large numbers of eggs found. Neither on 2nd February 1906 nor on 24th February 1909 were plaice eggs obtained. On 25th February 1907, 26 eggs were collected in the surface net, and 18 of these were in the initial stages of development. Fewer newly spawned eggs were procured in March, for, on the 26th of the month in the year 1908, only 28 eggs were got from the different water layers, and only 2 of these were newly spawned. Again, on 29th March 1910, 2 eggs in the "γ" stage of development were captured in the same number of hauls.

In February 1907 observations were made at Station 27 on the 25th, and two days later similar observations were taken at 1½ miles east of Cove and at Tod Head, W./N. 1½ miles, with the following results:—

	Developmental Stages.			
	α	β	γ	δ
Station 27	32	4	6	5
Cove	1	1	22	25
Tod Head	12	4	4	0

The eggs at Cove had thus been spawned for some considerable time, and probably they had not their origin in that locality. Observations in localities to the north and south do not help in determining from which direction they had been drifted.

Stations off Cove and Montrose.

On 23rd March 1909 two lines of stations at right angles to the coast at Cove and Montrose were examined. Five stations, eight miles apart,

were selected on each line. The inner station was one mile from the shore, and the most easterly one 33 miles distant.

East of Cove.

	α	β	γ	δ
1 mile . . .	0	0	2	2
9 miles . . .	12	20	20	6
17 ,, . . .	2	12	4	0
25 ,, . . .	2	0	4	0
33 ,, . . .	0	0	0	0

East of Montrose.

	α	β	γ	δ
1 mile . . .	2	4	2	0
9 miles . . .	14	0	10	2
17 ,, . . .	34	10	8	10
25 ,, . . .	4	3	10	6
33 ,, . . .	27	14	2	2

These figures represent the total number of plaice eggs at the different developmental stages caught at the various stations in a vertical haul and in surface, mid-water, and bottom hauls of one yalf-hour's duration. The frequencies of plaice eggs are in every case very low and cannot be compared with those from the richer grounds of the Moray Firth area. Such low frequency has been a characteristic feature of all the observations made on the East Coast of Scotland within this area, while these observations in themselves are too few, yet they are significant, and are not easy of interpretation. The presence of eggs in the later stages of development is proof, however, either that plaice spawned in the locality earlier in the year or that the eggs were drifted from some earlier spawning area. But we have already seen that a considerable number of newly spawned eggs were obtained on the 25th and 27th of February at Stations 27 and at Tod Head. Also, on the 27th of February, a number of eggs in the "δ" stage were taken near Cove, and if these had their origin on the East Coast of Scotland the commencement of the spawning season on the East Coast would have to be placed much earlier. It must not be forgotten also that plaice eggs have been found as early as December east of May Island. Unfortunately, no regular and extensive observations have been carried out in the coastal area; indeed, most of the observations in that area have been made far from the coast, where it is known that no large plaice are to be found at the spawning period. The numerous observations which have been carried out in the shallower coastal area in March, although not easily compared on account of their irregularity, help greatly towards a correct understanding of the conditions. As the absolute frequencies of plaice eggs in the collections have always been low, the differences between the various localities are correspondingly small, and therefore slight differences may be due entirely to errors of sampling or to special conditions in particular years. Thus the relatively high frequency of newly spawned eggs found 33 miles off Montrose on the 23rd March 1909, is exceptionally high, as observations made in other years in the near vicinity gave very poor results.

On the other hand, the frequency of freshly spawned eggs is much

higher at Tod Head, from five to twenty miles offshore, than either in the inshore or the offshore area. There is a distinct indication of this same condition in the results of the observations made in March 1909 in the line of stations at right angles to the coast. At the Station Tod Head, W./S. $\frac{3}{4}$ S. 5 miles, the frequency was very high on 29th March 1911. Here on this date 86 eggs were taken, and 82 of them were recently spawned.*

This zone of higher density apparently extends parallel to the coast as far north as the neighbourhood of Aberdeen, for a number of observations made in this belt give very significant figures. For example, at Stonehaven, W./N. $\frac{1}{4}$ N., 19 miles, on 29th March 1911, 20 newly spawned eggs were got in the surface cheese-cloth net, while 40 were taken in the Petersen Young Fish trawl at the surface. Again, at Girdleness, W./N. $\frac{3}{4}$ N., 10 miles, on 7th March 1912, 64 newly spawned eggs were taken in the cheese-cloth nets from surface, mid-water, and bottom. In addition, a large number of eggs in the later stages of development were also taken in this vicinity in the month of March. Eggs in the later stages of development had already been collected in February, before the newly spawned ones had appeared in the area, thus showing that a large number of these eggs in the later stages of development in March have been carried into the area.

Observations have also been made in the shallow off-shore area which lies between Tod Head and the Firth of Forth, but the frequencies are very low, and most of the eggs were in the later stages of development.

The experiments which have been conducted in the coastal area on the East Coast of Scotland, south of the Moray Firth, indicate that the earliest spawning does not fall much before the beginning of February, even in favourable years, and that the frequency of newly spawned eggs in the first quarter of the year is never high even in the most favoured localities. The results also indicate that plaice do not spawn in the very shallow water close to the shore, that few plaice spawn further than twenty miles off-shore, that most of the spawning plaice are confined to a narrow belt which runs parallel to the coast from the neighbourhood of Montrose northwards to the vicinity of Aberdeen; and, finally, that plaice eggs are carried into this belt from earlier spawning areas, and that these eggs in the later developmental stages appear in this belt before the freshly spawned eggs.

We are now in a position to correlate the isolated observations made and to take a wider and more general survey of the facts ascertained regarding the distribution of spawning plaice and the occurrence of their pelagic eggs in the Northern North Sea.

In many localities within this wide area plaice spawn in depths of less than fifty fathoms, and the fifty-fathom contour line marks the outer limit of distribution of newly spawned eggs. In very shallow

* Dr. Fulton (S.F.B.R., xx., 1901): "On the East of Scotland the spawning period extends as a rule from the end of January until the beginning of May, the maximum, according to the proportion of spawning fishes, being in March. This agrees with the limits of the spawning of the plaice in confinement in the ponds at Dunbar and the Bay of Nigg."

(S.F.B.R., viii., 1889): "In January and February very large ripe plaice congregate on grounds at distances from about 8 or 10 to 20 miles off the East Coast. In the neighbourhood of the Firth of Forth and St. Andrews Bay these shoals are mainly found about 8 or 10 miles off; off Montrose they may occur up to 25 miles."

water spawning does not take place, and newly spawned eggs are rarely found there. Neither ripe plaice nor newly spawned eggs are found in the sandy bays of the East Coast of Scotland, and they are also absent from the shallow waters of such localities as the Dornoch Firth and Burghead Bay. Proximity to the shore is not the dominant factor regulating the distribution of ripe plaice, although large numbers of freshly spawned eggs are often found close to the land in localities where there is a rapidly shelving coast line and where conditions are otherwise suitable. Spawning plaice do not penetrate far into the estuary of the Firth of Forth. The fifty-fathom line lies very close to the coast on the East Coast of Scotland, so that spawning is confined to a very narrow belt close to land. Few, if any, plaice spawn under the shelter of the islands.

Although newly spawned plaice eggs are found widely distributed in the zone within the fifty fathoms, with the exception of the shallow coastal area, spawning is most intensive in the intermediate depths. The frequency of spawning plaice is very low in depths between forty and fifty fathoms, and consequently freshly spawned eggs are not numerous in that extensive area to the east of Orkney. Outside the Moray Firth area, in depths between forty and fifty fathoms, spawning plaice are likewise of rare occurrence. The distribution of the newly spawned plaice eggs agrees even in detail with the known seasonal distribution of adults, for although large plaice are found more widely distributed throughout the year, even at depths of seventy fathoms, there is a segregation in the lesser depths during the spawning period. It is only in Statistical Areas XXIV. and XXX., where the depths appear suitable, that large plaice are found to be absent in the spawning months. This statement is supported both by the market statistical records and by the absence of plaice eggs over these areas during the spawning months.

But although spawning plaice are found widely distributed, with the exceptions already mentioned, over the intermediate depths indicated, they are not uniformly distributed, and the extent of distribution as well as the principal spawning time are not alike in the different localities. Even in any particular locality there are earlier and later years, good and bad years, for the annually recurring spawning phenomenon.

The facts as elucidated in the present communication are sufficient to show that "there are considerable differences from place to place as regards the commencement of the spawning period."

In general, the East Coast of Scotland is a late spawning area for plaice.

In the Dornoch Firth, however, spawning begins very early, and in favourable years a few plaice may spawn even in late November, so that the height of the spawning season may be reached before the end of January.

In the area to the east of the May Island there is more difficulty in defining the earliest date of spawning, but the evidence at present to hand shows that plaice may spawn here in December. The question of fixing the beginning of the spawning period here is difficult on account of the low frequency of spawning plaice in this area.

There is a retardation in the time of spawning from the coast outwards. This phenomenon is extremely well marked in the records

obtained from the line of stations east of Tarbet Ness, and is seen in lesser degree in the line east from the May Island.

Although spawning begins very early in the Dornoch Firth, the other coastal areas in the Moray Firth are later. Thus spawning is late at Noss Head.

At Shetland spawning begins almost two months later than in the Dornoch Firth.

Even within the Firth of Forth area plaice are later in spawning than east of the May Island.

"There are also marked differences with regard to the intensity of spawning over this wide area."

The most favoured spawning areas lie well within the Moray Firth. There is a gradual fall in the intensity of spawning from north to south along the East Coast of Scotland. The frequency is low in the area to the east of Orkney and at the Fair Isle. The intensity of spawning within the narrow belt at Shetland falls very far short of that in the Moray Firth.

In the central region of the Northern North Sea, in depths of over fifty fathoms, plaice do not spawn. Adverse conditions for spawning extend southwards through the "Gut," and prevail even over that shallower area east of the Firth of Forth between 0° and 2° E. longitude.

The analyses of the distribution of the spawning places may be carried much further. The observations made have again and again shown that plaice eggs are not uniformly distributed even within a comparatively restricted area. In other words, the spawning of plaice is distinctly localised; there are localities of higher and of lower density.

Within the Moray Firth area the localities most favoured by spawning plaice within the years under review were the following:

It has been found that every year plaice spawn in number in the vicinity of Tarbet Ness. There are, however, slight variations from year to year in the exact position of the most favoured places, for sometimes it lies within the Dornoch Firth and sometimes it is further off-shore. The frequency of spawning falls rapidly in an easterly direction. Plaice in considerable number frequent the neighbourhood of Lossiemouth and Burghead for the purpose of spawning. There is a fall in the intensity of spawning in an easterly direction from Lossiemouth along the Moray Firth Coast. Noss Head is also a locality where plaice spawn in number, but the frequency is very much less than at Tarbet Ness. The intensity of spawning between Dornoch Firth and Noss Head is much lower than at either of these localities. There is a spawning area in the neighbourhood of Bosey's Bank, and although spawning plaice are few in number their occurrence here is exceptional.

To conclude—plaice spawning is localised. It is true that each of the favoured localities has not been visited regularly, but the observations are otherwise so extensive that it is all but certain that these specialised localities are unique, and show but slight variations from year to year. Since these spawning localities are not fortuitous they must be intimately correlated with conditions which are advantageous to the species. The selecting of the spawning area determines more immediately the fate of the newly hatched larvæ and later the distribution of the very young forms.

While pelagic plaice eggs at the different stages of development, even with the larva ready to hatch, are exceedingly numerous, the

"Goldseeker" records prove that the numbers of larval and post-larval forms in the collections made during the period under observation are very few. Previous workers have commented on the paucity of larval and post-larval forms. Within the Moray Firth, as well as in other localities, where eggs with almost fully developed embryos have been taken, the occurrence of larval forms is extremely rare. It has been noted that there is a remarkable fall in the frequency of eggs in the later stages of development in most of the areas of high frequency for freshly spawned eggs. It has been suggested that this fall may be due in great measure to their dispersal over a wider area as they advance in development, and therefore a lower frequency of those eggs which are advanced in development might be expected at any particular locality. Undoubtedly the area of distribution of eggs in the later stages of development is more extensive than that of the freshly spawned ones. But this dispersal is not in itself sufficient to account for the rapid decline in their frequency, for even in the month of March there is no very obvious accumulation of earlier spawned eggs that have now advanced in development.

It has also been suggested that this loss is due to the high rate of mortality amongst the eggs. Observations made in the spawning season of 1914 gave a remarkable illustration of the importance of this factor, when an enormous number of dead eggs appeared in the February and March plankton. These dead eggs, though of slightly higher specific gravity than living ones, do not immediately fall to the bottom, but do so as soon as they are placed in a glass of fresh sea-water in the laboratory. Doubtless the movement of the water in the sea is sufficient to keep them in suspension for a time. These eggs which sink to the bottom of a jar of sea-water are opaque, and while many of them show no signs of the development of an embryo, others have embryos in all stages of development. There is thus a real mortality amongst the eggs, and death, in many cases at any rate, is not due to the lack of fertilisation. It is impossible from preserved material to separate eggs living and fertilised at the time of capture from those already dead or unfertilised.

While it is difficult to apportion the factors, dispersal, and mortality, yet these, taken in conjunction with the fact that the present communication is brought up to the end of March only, explain the paucity of records of larval forms.

The tables of occurrence of plankton stages of plaice in the Northern North Sea from January to March show clearly that the area of distribution of these young forms thus early in the year is not more extensive than the area of distribution of newly spawned eggs. Indeed, most of these plankton forms were taken in close proximity to those areas which have already been shown to be favoured spawning places. Even although our information regarding the larval and post-larval forms appears meagre it is trustworthy, owing to the fact that there is at this period no doubt as to the identification of the forms. Confusion with the young stages of such a closely allied form as the Common Dab (*Pleuronectes limanda*) is entirely eliminated during these early months. While most of the specimens captured were from 6 to 7 mm. long, none exceeded 7·5 mm. In all cases the yolk sac had disappeared, and in many of the prepared specimens it was clearly evident that plankton feeding had begun, and although

some of the material had been preserved in formalin for a number of years Coscinodiscus could still be identified lying in the intestinal tract in a number of the specimens.

The comparatively rich collections of plaice larvæ from stations in the Moray Firth in January 1905 is extremely interesting and agrees with the condition found for the early appearance of the eggs in that spawning year. Spawning season 1904–1905 was an early one in that locality, and the eggs from which these larvæ had hatched out may have been spawned in the last days of November or early in December. The appearance of such a large number of larval forms at Station 30 thus early in the season is also significant as it was shown that eggs in the later stages of development also appeared early at these offshore stations, earlier, in fact, than the newly spawned eggs. Both the eggs in the later stages of development and the larvæ at the offshore stations must have been derived from an earlier spawning area, and the only area which has been shown to be earlier is the Dornoch Firth.

Similarly, in March 1906, at Troup Head and Kinnaird Head, where the percentage of eggs in the later stages of development was high, hatched out larvæ were found before larvæ had appeared in the plankton at Lossiemouth, which is a much more important spawning ground. These facts help to confirm the view that there is an alongshore drift eastwards of eggs and larvæ from Lossiemouth.

It is known that the plaice after metamorphosis finds a suitable habitat on shallow sandy flats, and that such favourable localities in Scottish waters occur only on the very margin of the coast. The advantages of this habitat to the species have been aptly put by Dr. Fulton :—" The selection of this habitat is clearly of advantage to the species in summer, since it is the region of maximum warmth, but it is curious that the beach should still be frequented in winter when it is the coldest region ; for although the larger individuals and some of the others appear to withdraw to slightly deeper water, they may still be procured on the beach in considerable numbers. There is probably a greater advantage to the species by the comparative immunity from enemies which the situation confers, since few piscivorous fishes venture into shallow water unless in exceptional circumstances."

It is desirable, even at this stage, to enquire how far the study of the distributions of eggs in the various stages of development provides information as to the conditions as well as to the localities in which the tiny larvæ are hatched out. Are the chief spawning places such that, when the bulk of the larvæ appear from the egg, they find themselves in the immediate neighbourhood of a locality suitable for development ? To what extent do the prevailing physical conditions assist the passive eggs and helpless larvæ in securing a suitable habitat for further development ? It is of vital importance to the species that there should be an intimate connection between the spawning grounds and the localities suitable for growth.

It is known that as the tiny plaice grow they gradually migrate seawards to deeper waters, and from a knowledge of these movements Heincke has been able to formulate the following law of distribution for the plaice :—" The size and age of the plaice in a definite part of the North Sea are inversely proportional to the density of their occur-

rence, but directly proportional to the distance of the locality from the coast and to its depth." Thus the growing plaice will come under the influence of the trawl and be captured in largest numbers on those grounds which are adjacent to the suitable gathering places of the larvæ. Our most recent knowledge of the distribution of small (or young) plaice in Scottish waters is derived from the publications of Professor D'Arcy W. Thompson and Dr. Fulton. Professor Thompson shows that small plaice are practically absent in our deeper waters, and that, actually and relatively to the other sizes, they increase in numbers as we pass to the shallower zones. Dr. Fulton gives a detailed account of the occurrence of small plaice within the different statistical areas.

That the pelagic eggs of the plaice, as the embryo advances in development, tend to sink to the lower water layers has been fully shown in the tables already given. But even if this sinking of the egg be doubted, the "Goldseeker" records amply prove that eggs in the first stages of development also occur in the deeper water layers. Any efforts made to trace the influence of the drift of the waters on the fate of the eggs and newly hatched larvæ must necessarily take into consideration not only the movements at the surface but also the direction and velocity of the deeper currents.

The general movements of the currents in the Northern North Sea have recently been very fully investigated by the use of different types of floating bottles. Dr. Fulton was the first to employ this means of studying on a large scale the direction and velocity of the surface currents on the Scottish Coast, while Captain Brown has, by means of specially loaded bottles, added greatly to our knowledge of the movements of the bottom currents. These experiments prove the existence of a circular movement of the waters in the Northern North Sea, the bottom currents moving in the same general direction as the surface ones but at a slower rate. It may be stated roughly that the drift of the water entering the North Sea from the west of Orkney and Shetland turns southwards on the western side of the North Sea, then eastwards towards the Continent, and finally northwards along the coast of Norway. The average rate of the surface water off the East Coast of Scotland is from 2 to 3 miles per day. The general tendency would therefore be for pelagic eggs to be carried southwards and eastwards, but Dr. Fulton has shown that in the case of the plaice there is a compensatory northerly movement of mature adults. Such is a broad statement of the general facts.

In estimating the influence of the currents the fact must not be ignored that plaice eggs are spawned only at particular seasons of the year and in numbers only in restricted areas. It is therefore obvious that local and seasonal variations of current, due to the configuration of the land or sea bottom, the prevailing winds, and the volume of the main inflowing stream, may play a very important part in determining the dispersal of pelagic eggs all spawned in relatively shallow water in the vicinity of the Scottish Coast.

Further, no doubt the time as well as the duration of spawning have an intimate connection with the seasonal variations of current. Dr. Damas has shown that saithe, for example, spawn in large numbers on the Tampen at a time when there is a hydrographic equilibrium over that area.

Experiments with drift bottles have proved that the general south-going current is profoundly modified in the Moray Firth, for while the bulk of the water after impinging on the coast of Banff and Aberdeen continues its southward course a portion is deflected westwards to the inner reaches of the Firth. The third western meridian is roughly the line of division of the directions of the flow of these bodies of water, the westerly deflected portion of the current forming a series of eddies within the Firth. Captain Brown shows that not only is there a south-westerly set towards the Cromarty Firth, but that these currents are continued along the shores of Sutherlandshire.

Now our most important plaice spawning grounds lie within this region of the Firth, and their position is such that the drift of the pelagic eggs is affected by the currents mentioned. The important spawning ground off Lossiemouth lies just at the point where the final separation takes place between the east and west-going currents. It has already been shown that there is a gradual increase in the percentage of eggs in the later stages of development eastwards along the coast from Lossiemouth. In addition, the region off Tarbet Ness is known to be not only an early spawning area but one of high density. This area of high density is of considerable extent, for in the statistics already given there is a great similarity at any particular time in the percentages of eggs at the same stages of development. This similarity is easily explained by the existence of a circular movement of the water in the locality. At a given moment the stages of development of eggs at Helmsdale agree rather with the conditions at Tarbet Ness than those at Noss Head. The circular motion of the waters would also fully account for the appearance of eggs with well developed embryos on the off-shore grounds before spawning had begun there. These eggs must have been derived from the early spawning grounds of the Dornoch Firth or Tarbet Ness since spawning had not begun within the areas to the north. It might be suggested that eggs in an advanced stage of development, which appear early on the south edge of Smith Bank, had been carried from spawning grounds on the North of Scotland or to the east of Orkney. A reference to the remarks already made, when the separate stations were being considered, will show how unlikely it is that, thus early in the season, these eggs could have been carried from the northern areas. Neither can they be derived from Noss Head since that has been shown to be a later spawning area.

The influence of the south-flowing current is well seen in the non-appearance of eggs in the later stages of development to the east of Orkney even in the month of March, although spawning begins there in February.

In the present communication little can be said with certainty concerning the conditions on the more northerly areas around Shetland since it has been found that spawning is late in that locality. This much, however, may be said that spawning is not general in the shallow coastal zone round the Islands.

Dr. Fulton has traced out the general southerly movement of the surface waters on the East Coast of Scotland, and has shown how the current impinges on those portions of the coast which lie at right angles to its general flow, and that on the Yorkshire coast it is finally deflected eastwards towards the continental coast. Captain Brown describes

how the bottom currents on the East Coast of Scotland divides in the region of the "Long Forties," and how one branch takes a south-westerly set towards the Firth of Forth. This branch again divides off Fife Ness, and in addition to the set into St. Andrews Bay a deep current flows northwards, across the Tay and up the Scottish Coast as far as Johnshaven. There is, of course, as has been stated, a close connection between surface and bottom currents, and the stranding of surface bottles on the East Coast of Scotland would seem to show that the configuration of the coast and sea-bottom south of Buchan Ness modifies the general direction of flow of the western periphery of the south-going current.

We have seen that spawning on the East Coast of Scotland is somewhat sharply restricted in an easterly direction, and that the chief spawning grounds lie in a narrow belt not more than twenty miles from the coast, stretching from Montrose to Aberdeen. This zone is sandwiched in between the main south flowing current and the north-flowing branch from Fife Ness, so that eggs spawned in an area so situated are thus less liable to be drifted extreme distances seawards or southwards. No doubt most of the eggs which are carried eastwards along the south shore of the Moray Firth are found ultimately on the sandy shallows southwards from Buchan Ness. Now it has been shown that the maximum catch of small plaice in any area in the North Sea frequented by Aberdeen trawlers was in statistical area XXIII., and area XXVIII. has the highest mean density of small plaice on the Scottish Coast. In all probability therefore the supply of small plaice on the East Coast of Scotland within these statistical areas is maintained not only from adjacent spawning ground but also from spawning grounds in the Moray Firth, east of Lossiemouth.

The annexed chart illustrates, in a summary way, many of the points already set forth regarding the distribution of the pelagic eggs of the plaice in the early months of the year and its relations to the general distribution of plaice classified as "large" and "small" in the market statistics. The limits of distribution of large plaice, that is, those plaice which have reached spawning age, agree very closely with the bathymetric contour line of 50 fathoms, and the area within which the pelagic eggs of the plaice have been found is co-extensive with the area of distribution of these adult fish. All observations made to the east of this line have given negative results, whilst at most of the localities within the shallower area positive records have been obtained on some occasion. One exception may be made to this general statement, as it is probable that a very small number of plaice may spawn in the neighbourhood of the Bergen Bank (59° 55′ N., 2° E.). I am indebted to Mr. George Robertson, Captain of the S.T. "Ortes," for this information. On the 28th April 1914 he brought to Aberdeen market three female plaice which he had captured in the locality. Two of these were spent fish in very poor condition, but the third was fully ripe with running spawn, a sample of which was kept. This information confirms a "Goldseeker" record which I had long looked upon as an anomalous one. On 15th March 1908 a plaice egg in the "γ" stage of development was captured in the plankton at Station 7B (60° 35′ N., 1° 50′ E.). This is the solitary record obtained by the "Goldseeker" from the large deep area east of the fifty fathom line, but when taken in con-

junction with the record of capture of the mature plaice it confirms the view that some plaice may spawn on the relatively shallower Bergen and Viking Banks.

While the occurrence of extremely small plaice on the beaches is not indicated, the chart shows at a glance how the "small" plaice (in the market sense), which are immature, are much more restricted in distribution than the large plaice. On the other hand, although plaice eggs are found as widely distributed as the mature or large plaice, the chief spawning areas lie within the area of distribution of the small plaice. Mature plaice are therefore more numerous in the shallower zones during the spawning months. This statement is confirmed by the records of the seasonal distribution of large plaice within the different statistical areas. The spawning grounds of the mature plaice are more localised than their feeding grounds.

If a chart showing the direction of the prevailing currents in the Northern North Sea is superimposed on the chart of distribution of the pelagic plaice eggs it is seen that the principal spawning areas lie within the western periphery of the south-going current. It is true that the south-going current tends to carry the passively floating plaice eggs and the helpless larvæ in that direction, but it is also true that there is a general movement northwards of adult plaice which compensates for this southerly drift.

The contour of the East Coast of Scotland is such that the main south-going current is shouldered off at Noss Head to impinge on the south shore of the Moray Firth, east of Lossiemouth. The main spawning grounds for plaice in the Moray Firth lie to the westwards of the main stream within the triangle so formed. Eggs spawned in this area are therefore in an eddy and are not directly influenced by the main current. Again, the south-going current is shouldered off the coast at Kinnaird Head and Buchan Ness, whilst there is a further divergence of the current, especially in the bottom layers, in the neighbourhood of the "Long Forties," so that the western part branches sharply to the southwards and south-west, forming a very decided set towards the Firth of Forth and the coasts lying south of it. It has been shown, however, that the chief spawning localities on the East Coast of Scotland lie within the triangle, the base of which extends from Kinnaird Head to Berwick and the apex of which lies in the vicinity of the "Long Forties." The chief spawning localities for plaice on the Scottish East Coast are thus so situated that the passive eggs are carried a minimum distance from the localities in which they were spawned.

There is apparently little or no correlation between these favoured spawning places and the temperature and salinity of the water, although these factors in themselves are not unimportant for the welfare of the species. This is mentioned because the Dutch investigators have shown that in the Southern North Sea by far the most important spawning area for plaice is in the south-western corner where the temperature and salinity are high. But even in this case, too, these factors of salinity and temperature may be of less importance than the influence of the prevailing current on the welfare of the species since the eggs and larvæ are gradually carried eastwards towards the great nursery for plaice in the south-east corner of the North Sea.

No doubt the time of spawning is influenced by the temperature, as it has been observed that in the Moray Firth area spawning occurs later and later in an easterly direction.

A study of the distribution of the main spawning areas in the Northern North Sea and the influence of the prevailing currents on the passive eggs and helpless larvæ suggests that there is probably little or no interchange between the stock of plaice on the Scottish Coast and that of the Southern North Sea. Even in statistical areas XXIX. and XXX., where the depths are not excessive, small plaice are but poorly represented since the south-westerly branch of the main current tends to carry coastwise eggs spawned within or to the north of these areas.

The selection of such definite spawning places; the influence of the prevailing currents on the plankton stages; the gradual off-shore movement of the young plaice with increasing age and size; the compensatory northerly movement of adult plaice; all tend to show that the stock of plaice on the Scottish coast is practically a self-contained one. The life-cycle from egg to adult is passed through within the area. If such be so, problems concerning the maintenance of the stock are much simplified.

The present contribution does not deal with the entire spawning period on the Scottish Coast, but it is desirable even at this stage to review the facts already elucidated for a part of the season and to consider their bearing. So often has the problem been attacked by investigators, more particularly by Scottish workers, and so numerous have their publications been that it is almost impossible to acknowledge briefly one's indebtedness to individual writers. Special reference must be made to contributions on this subject by Dr. Fulton, especially to his work on the relation of the currents of the North Sea and their bearing on the spawning of the common food fishes.

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TABLE I.—STATIONS INVESTIGATED during the months December to March (1904-1913.

Station.	Lat. Long.	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
2	58° 36′ N. ; 1° 46′ W.	..	F	J	F	M	F	M	..	..	..
3	59° 10′ N. ; 1° 27′ W.	..	F	J	F	M	F	M	..	..	..
4	59° 26′ N. ; 1° 20′ W.	..	F	J	F	M	F	M	..	..	M
5	59° 40′ N. ; 1° 14′ W.	..	F	F	F	M	F	M	..	..	M
5a	60° 05′ N. ; 0° 48′ W.	..	..	..	F	M	F	M	..	..	M
5b	60° 31′ N. ; 0° 35′ W.	..	M	..	..	M	F	M	..	..	..
6	60° 37′ N. ; 0° 30′ E.	..	..	..	..	M	F	M	..	..	..
6a	60° 04′ N. ; 0° 33′ E.	..	..	..	..	M	F	M	..	..	..
7	61° 06′ N. ; 2° E.	..	..	..	..	M	..	..	..	..	..
7a	60° 45′ N. ; 2° 30′ E.	..	..	..	..	M	..	..	..	..	..
7b	60° 35′ N. ; 1° 50′ E.	..	..	..	..	M	..	..	..	..	..
7c	60° 34′ N. ; 1° 15′ E.	..	..	..	..	M	..	..	..	..	..
8	61° 30′ N. ; 3° 3′ E.	..	..	..	..	M	..	..	..	..	..
9	61° 32′ N. ; 2° 5′ E.	..	..	..	..	M	..	..	..	..	..
10	61° 34′ N. ; 0° 39′ E.	..	..	..	..	M	..	..	..	..	..
11	61° 36′ N. ; 0° 50′ W.	..	..	..	..	M	..	..	..	..	..
11a	61° 42′ N. ; 2° W.	..	..	..	..	M	..	M	..	..	..
12	61° 3′ N. ; 0° 34′ W.	..	..	..	..	M	F	M	..	..	..
12a	60° 42′ N. ; 1° 25′ W.	..	..	..	..	..	F	..	..	..	..
22	59° 36′ N. ; 0° 41′ W.	..	F	F	F	M	F	M	..	..	..
23	59° 31′ N. ; 0° 37′ E.	..	F	J	F	M	F	M	..	..	..
24	58° 55′ N. ; 0° 4′ E.	..	F	F	F	M	F	M	..	..	..
25	58° 11′ N. ; 0° 32′ W.	..	F	F	F	M	F	M	..	..	..
26	58° 9′ N. ; 1° 50′ W.	..	F	J	JF	M	..	M	..	..	..
27	57° 30′ N. ; 1° 19′ W.	..	..	F	F	M	F	M	..	..	..
28	57° 53′ N. ; 3° 48′ W.	D	DJFM	DFM	F	DJF	F	DF	FM	J	..
29	57° 57′ N. ; 3° 20′ W.	D	JFM	..	..	..	..	..	..	..	..
30	58° N. ; 2° 54′ W.	D	DJFM	DF	F	DJF	F	DF	FM	..	..
31	58° 4′ N. ; 2° 28′ W.	D	JFM	..	..	..	..	..	..	..	..
32	58° 8′ N. ; 2° W.	..	..	D	F	DJF	F	F	M	..	..
33	58° 13′ N. ; 1° 32′ W.	D	JFM	..	..	..	..	..	..	..	..
34	58° 17′ N. ; 1° 3′ W.	..	..	D	F	DJF	F	F	M	..	..
35	58° 22′ N. ; 0° 36′ W.	D	..	F	..	..	..	..	..	..	..
36	58° 26′ N. ; 0° 8′ W.	..	F	D	F	DF	F	..	..	..	..
37	58° 30′ N. ; 0° 20′ E.	..	..	..	..	..	..	..	..	..	..
38	58° 34′ N. ; 0° 47′ E.	D	D	DF	..	DF	F	..	..	..	..
38a	58° 42′ N. ; 1° 44′ E.	..	..	..	..	..	..	F	F	..	..
39b	57° 59′ N. ; 0° 57′ E.	..	..	DF	F	DF	..	F	F	..	..
40	57° 34′ N. ; 0° 1′ W.	D	D	..	..	..	..	..	..	..	..
40b	57° 24′ N. ; 1° 7′ E.	..	..	DF	F	DF	F	F	F	..	..
41a	56° 48′ N. ; 1° 19′ E.	..	..	DF	F	DF	F	F	F	..	..
41b	56° 42′ N. ; 0° 35′ E.	..	..	F	..	DF	F	DF	F	..	..
41c	56° 35′ N. ; 0° 10′ W.	..	..	DF	F	DF	F	DF	F	..	..
42	56° 28′ N. ; 0° 53′ W.	D	..	F	..	DF	F	DF	F	...	..
43	56° 24′ N. ; 1° 21′ W.	..	..	D	F	DF	F	DF	F	..	..
44	56° 20′ N. ; 1° 49′ W.	D	..	DF	F	DF	F	DF	F	..	..
45	56° 16′ N. ; 2° 17′ W.	D	FJ	FJ	..	DF	F	DF	F	..	..
46	56° 10′ N. ; 2° 45′ W.	D	F	DFJ	F	DF	F	DF	F	..	..
Firth of Forth											
I.	For Firth of Forth	D	..	FM	DJ	..	M	..	JM	D	M
II.	Stations see XIVth	..	..	M	D	..	M	..	M	FD	M
III.	Annual Report	..	..	M	..	..	M	..	FM	..	M
IV.	Scottish Fishery	..	..	M	D	..	..	..	FM	D	M
V.	Board for 1895,	..	..	M	D	..	M	..	JM	FD	M
VI.	Part iii. p. 131.	..	..	..	D	..	M	..	M	FD	M
VII.	..	..	..	FM	..	..	M	..	JM	FD	M
VIII.	..	..	..	..	D	..	..	..	M	FD	M
IX.	..	..	..	'M	D	..	..	..	JM	D	M

Station.	Lat. Long.	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Moray Firth. I.	Moray Firth Stations, see XIXth Annual Report S.F.B. for 1900, Part iii. p. 18.	..	..	FM	DM	JM	..	F	..	JD	..
II.		..	..	F	..	..	..	..	..	..	..
III.	Cromarty Firth.	..	..	F	M	..	..	..	..	..	..
IV.	Dornoch Firth.	..	..	F	..	M	..	..	F	..	..
V.		..	..	F	..	..	..	..	F	..	..
VI.		..	..	F	M	..	..	..	..	..	..
VII.	..	..	..	FM	..	..	..	F	F	..	..
VIII.	..	..	..	M	..	JM	..	..	..	..	..
IX.	..	..	..	M	M	..	..	..	..	..	..
X.	..	..	..	M	..	M	..	..	..	..	..
XVI.	..	..	..	..	..	M	..	F	..	..	..
	Noss Head.	..	M	M	..	..	..	..	..	..	..
	Lybster, 58° 18′ N.; 3° 21′ W.	..	..	M	..	..	..	..	..	..	..
	Helmsdale, 58° 6′ N.; 3° 28′ W.	..	..	M	..	..	..	..	..	..	..
	Lossiemouth.	..	..	M	..	J	..	..	..	..	..
	Portknockie.	..	..	M	..	..	..	..	..	..	..
	Troup Head.	..	..	M	..	M	..	..	..	..	..
	Kinnaird Deep.	..	..	M	..	..	..	..	..	..	..
	Sutors of Cromarty.	..	..	..	..	M	..	..	..	..	..
	Rattray Head.	..	M	..	M	..	..	..	..	..	..
	Buchan Ness.	..	..	..	M	F	..	..	..	..	..
	Collieston.	..	..	M	..	..	..	..	..	..	..
	Cove.	..	..	..	F	..	M	..	..	..	..
	Montrose.	..	..	..	MF	..	M	..	..	..	..
	Lunan Bay.	..	..	..	M	..	..	..	..	..	..
	Carnoustie Bay.	..	J	..	..	..	..	..	..	..	..
	May Island.	..	..	F	FM	..	M	..	M	..	..
	56° 4′ N.; 2° 10′ W.	..	..	..	..	..	M	..	..	..	..
	56° 22′ N.; 1° 33′ W.	..	..	..	..	..	..	..	M	..	..
	56° 29′ N.; 2° 21′ W.	..	..	..	..	..	..	..	M	..	..
	56° 17′ N.; 1° 58′ W.	..	..	..	..	..	..	..	..	M	..
	56° 27′ N.; 1° 55′ W.	..	..	..	..	..	..	..	..	M	..
	56° 38′ N.; 1° 50′ W.	..	..	..	..	..	..	..	..	M	..
	56° 39′ N.; 1° 25′ W.	..	..	..	..	..	M	..	..	..	..
	56° 40′ N.; 1° 40′ W.	..	..	..	..	..	M	..	..	..	..
	56° 41′ N.; 1° 55′ W.	..	..	..	..	..	M	..	..	..	..
	56° 57′ N.; 2° 6′ W.	..	..	..	..	..	..	..	M	..	..
	56° 58′ N.; 1° 36′ W.	..	..	..	..	..	..	..	M	..	..
	56° 47′ N.; 1° 50′ W.	..	..	..	..	..	..	..	..	M	..
	56° 58′ N.; 1° 48′ W.	..	..	..	..	..	..	..	..	M	..
	56° 40′ N.; 1° 20′ W.	..	..	..	..	..	..	..	M	..	..
	57° N.; 1° 10′ W.	..	..	..	..	..	..	..	M	..	..
	57° 8′ N.; 1° 44′ W.	..	..	..	..	..	..	..	..	M	..
	57° 2′ N.; 1° 2′ W.	..	..	..	..	..	M	..	..	..	..
	57° 4′ N.; 1° 17′ W.	..	..	..	..	..	M	..	..	..	..
	57° 5′ N.; 1° 30′ W.	..	..	..	..	..	M	..	..	..	..
	57° 7′ N.; 1° 45′ W.	..	..	..	..	..	M	..	..	..	..
	58° 5′ N.; 3° 13′ W.	..	..	..	M	..	..	..	..	..	..
	58° 12′ N.; 2° 52′ W.	..	..	M	..	..	..	..	..	..	..
	58° 18′ N.; 2° 25′ W.	..	M	..	..	..	..	..	..	..	..
	57° 10′ N.; 1° 50′ W.	..	..	..	..	..	D	..	..	..	..
	Pentland Skerries.	..	..	..	..	M	..	..	..	..	..
	Pentland Firth.	..	M	..	..	M	..	..	..	..	..
	Dunnet Head, S.-E./S. 4½ miles.	..	..	..	..	..	..	..	..	..	M
	Auskerry Light, W./N. ½ N. 6 miles.	..	..	..	..	..	..	..	..	..	M
	Lerwick Harbour.	..	DM	..	..	..	..	..	..	..	..
	Bressay.	..	M	..	..	..	..	..	..	..	..
	Tofts Vol.	..	M	..	..	..	..	..	..	..	..
	Wether Holm.	..	M	..	..	..	..	..	..	..	..
	Dales Voe.	..	M	..	..	..	..	..	..	..	..

Station.	Lat. Long.	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
	Ramad Stacks.	..	M	..	..	..	..	..	..	..	..
	Sullom Voe.	..	M	..	..	..	..	..	..	..	..
The Minch.	Cape Wrath, S.E. 9 miles.	..	..	..	..	..	..	..	..	..	M
	Butt of Lewis, W./S. 5 miles, S. $5\frac{1}{2}$ miles.	..	..	..	..	..	..	..	..	..	F
	Cellar Head, W./N. $\frac{1}{2}$ N. 6 miles.	..	..	..	..	..	..	..	..	..	F
	Tolsta Head, W. $\frac{1}{2}$ S. 7 miles.	..	..	..	..	..	..	M	..	..	..
	Tiumpan Head, S.-W/S. 4 miles.	..	..	..	..	..	..	M	..	..	F
	Tiumpan Head, W.-N.-W. 8 miles.	..	..	..	..	..	..	M	..	..	F
	Arnish Point, N.N.-W. $5\frac{1}{2}$ miles.	..	..	..	..	..	..	M	..	..	F
	Holness Point, N. $5\frac{1}{2}$ miles.	..	..	..	..	..	..	..	..	..	F
	Shiant Islands, W. $\frac{3}{4}$ S. $9\frac{1}{2}$ miles.	..	..	..	..	..	..	..	..	..	F
	Shiant Islands, S.-W./W. $16\frac{1}{2}$ miles.	..	..	..	..	..	..	..	..	..	F
	Ru Rhea, S. $\frac{1}{2}$ W. 10 miles.	..	..	..	..	..	..	M	..	..	..
	Ra Stoer, S. 11 miles.	..	..	..	..	..	..	M	..	..	F
	Ru Stoer, E. $\frac{1}{4}$ S. 3 miles.	..	..	..	..	..	..	..	..	..	F
	Ru Stoer, E. $\frac{1}{4}$ N. 11 miles.	..	..	..	..	..	..	..	..	..	F
	Bulgie Island, E.-N.-E. 7 miles.	..	..	..	..	..	..	M	..	..	..

TABLE II.—PLAICE EGGS.—Number at "*a*" stage of development in one

	Locality.	Stations. 2	3	4	5	5a	22	26	27	28	29	30	31	32	33	34
JANUARY.	Highest Number	0	0	0	–	–	–	0	–	760	14	13	0	0	0	0
	Number of Hauls	1	1	1	–	–	–	2	–	3	1	2	1	1	1	1
	Average . .	0	0	0	–	–	–	0	–	346	14	6·5	0	0	0	0
FEBRUARY.	Highest Number	8	6	2	16	0	4	12	18	560	18	64	0	2	0	0
	Number of Hauls	3	4	3	4	2	4	2	2	7	1	7	1	3	1	4
	Average . .	3·3	2	·6	4·5	0	1	10	9	151	18	10	0	·6	0	0
MARCH.	Highest Number	0	0	0	0	10	0	0	2	510	404	4	8	0	0	0
	Number of Hauls	2	1	1	2	1	0	1	2	3	1	2	1	1	2	1
	Average . .	0	0	0	0	10	0	0	1	199	404	2	8	0	0	0

	Locality.	Firth of Forth Area. I.	II.	III.	IV.	V.	VI.	VII.	VIII	IX.	May Island.
JANUARY.	Highest Number .	0	–	–	–	0	–	0	–	8	–
	Number of Hauls .	2	–	–	–	1	–	1	–	1	–
	Average . .	0	–	–	–	0	–	0	–	8	–
FEBRUARY.	Highest Number .	0	–	0	0	0	0	0	–	2	–
	Number of Hauls .	1	–	1	1	1	1	1	–	1	–
	Average . .	0	–	0	0	0	0	0	–	2	–
MARCH.	Highest Number .	6	4	0	0	0	20	6	32	14	2
	Number of Hauls .	5	4	2	2	3	6	3	1	2	3
	Average . .	2	2	0	0	0	6·3	2	32	7	·6

metre cheese-cloth net, one half-hour at surface (1904–1913).

					Moray Firth Area.										
42	43	44	45	46	I.	II.	III.	IV.	V.	VI.	VII.	VIII	IX.	X.	XVI.
–	–	–	1	0	174	–	–	–	–	–	–	–	–	–	3
–	–	–	2	2	4	–	–	–	–	–	–	–	–	–	1
–	–	–	·5	0	99	–	–	–	–	–	–	–	–	–	3
2	0	0	20	0	10	3	1	764	1319	362	31	–	–	–	0
5	5	6	6	7	3	1	1	2	2	1	3	–	–	–	1
·4	0	0	5·3	0	5·3	3	1	383	680	362	19	–	–	–	0
–	–	–	–	–	130	–	2	25	–	234	–	110	94	105	0
–	–	–	–	–	3	–	2	1	–	1	–	2	1	2	1
–	–	–	–	–	63	–	1	25	–	234	–	96	94	97	0

Berriedale.	Noss Head.	Helmsdale.	Lybster.	Sinclair Bay.	Smith Bank.	Lossiemouth.	Portknockie.	Kinnaird Deep.	Troup Head.	Tarbet Ness.	Covesea Light.	Bressay.	Ramna Stacks.	Carnoustie.	Pittenweem.	Tod Head.
–	–	–	–	–	–	–	–	–	–	–	4	–	–	0	–	–
–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–
–	–	–	–	–	–	–	–	–	–	–	4	–	–	0	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
–	34	28	2	12	4	1294	68	2	10	102	–	102	0	–	–	–
–	1	1	1	1	1	1	1	1	2	1	–	1	1	–	–	–
–	34	28	2	12	4	1294	68	2	9	102	–	102	0	–	–	–

Plaice Eggs.—Number at "a" stage of development in one metre cheese-cloth net one half-hour at surface (1904–1913).

	Locality.	Cove, W.N.W. 1 mile.	57° 7′ N. 1° 45′ W.	57° 5′ N. 1° 30′ W.	56° 39′ N. 1° 25′ W.	56° 40′ N. 1° 40′ W.	56° 41′ N. 1° 55′ W.	Montrose, W.N.W. 1 m.	56° 22′ N. 1° 53′ W.	56° 40′ N. 1° 20′ W.	57° 0′ N. 1° 20′ W.	56° 19′ N. 2° 20′ W.	56° 57′ N. 2° 6′ W.	56° 58′ N. 1° 36′ W.	56° 17′ N. 1° 58′ W.	57° 8′ N. 1° 44′ W.	Collieston.	56° 27′ N. 1° 55′ W.
January.	Highest Number .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Number of Hauls .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Average .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
February.	Highest Number .	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Number of Hauls .	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Average .	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
March.	Highest Number .	0	6	2	2	6	4	8	0	0	0	0	82	20	18	40	2	2
	Number of Hauls .	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Average .	0	6	2	2	6	4	8	0	0	0	0	82	20	18	40	2	2

TABLE III.—PLAICE EGGS.

DECEMBER 1904–1913.

Year.	Date.	Station.	1 m. ch. cl. V. Haul.	1 m. ch. cl. Horiz. ½ hr.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
1904	19	28	0	3	95·2	4·8	..	..	126
	20	29	0	4	..	..	100	..	2
	22	45	0	1	100·	..	..	..	1
1908	1	28	0	0	100·	..	..	..	2
1910	11	28	0	0	100·	..	..	..	2

JANUARY 1905–1913 (inclusive).

Year.	Date.	Station.	1 m. ch. cl. V. Haul.	1 m. ch. cl. Horiz. ½ hour at 0 m.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
1905	5	May Id. W. ¾ ml.	..	..	100·	0	0	0	1
	13	M. F. XVI.	..	63	4·76	17·46	66·67	11·11	63
	25	28	1	267	96·05	1·47	1·75	·72	3877
	25	29	0	46	60·9	4·34	26·09	8·68	23
	26	30	0	1	8·80	10·00	48·89	32·22	90
	26	31	0	16	0	0	12·5	87·5	8
	26	33	0	0	0	0	100·	0	4
1906	18	45	0	0	100·	0	0	0	1
1908	14	28	1	183·2	82·84	13·51	3·65	0	962
	14	30	0	28	92·85	..	7·15	0	14
	23	S.E./E.2′	0	70	89·5	3·9	6·6	0	76
	23	Burghead, S.E. 3′	1	192	87·00	7·00	6·00	0	301
	23	S.½W. 2′	1	214	77·85	10·13	12·02	0	158
	24	Covesea Light, S.W./S.8′	0	4	36·5	0	63·5	0	11
1911	25	Firth of Forth IX	1	8	85·71	14·30	0	0	14
1912	8	28	0	16	84·2	5·3	10·5	0	19

FEBRUARY 1905.

Date.	Station.	Net. V.	Net. Horiz. ½ hr.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
21	26	1	12	100·	..	..	..	7
22	2	0	10	80·	20·	..	..	5
22	3	0	2	100·	..	..	..	1
22	4	0	2	100·	..	..	..	1
22	5	2	34	52·6	5·2	31·5	10·5	19
22	22	1	10	33·4	16·7	33·4	16·7	6
23	33	0	0	..	9·1	45·4	45·4	11
23	31	0	12	16·7	..	..	83·4	6
23	30	0	24	25·0	41·7	33·3	..	12
24	28	4	74	65·3	13·0	15·0	6·7	2719
28	29	1	32	52·9	5·9	17·6	23·5	17
28	45	3	23	92·0	2·3	5·6	..	88
28	46	0	0	66·6	33·3	..	..	3

FEBRUARY 1906.

Date.	Station.	Net. V.	Net. Horiz. Surface. ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
2	5	0	0	100·	..	..	..	1
17	45	0	6	86·2	5·2	8·6	..	58
17	44	0	2	50·	50·	..	..	2
17	42	0	1	81·2	12·5	..	6·2	16
19	30	1	5	13·2	34·0	50·9	1·9	52
20	28	2	37	81·6	16·6	1·7	..	415
26	Cromarty.	..	5	20·	20·	20·0	40·0	5
26	Moray Firth, II.	..	5	60·	40·0	..	..	5
26	Moray Firth, I.	14	..	71·4	14·3	14·3	..	14
27	Moray Firth, IV.	..	797	95·86	3·51	·62	..	797
27	Moray Firth, V.	..	1370	96·27	·14	2·19	·14	1370
27	Moray Firth, VI.	..	397	91·18	6·04	2·78	..	397
27	Moray Firth, VII.	..	38	65·79	7·89	13·16	13·16	38

FEBRUARY 1907.

Date.	Station.	Net. V.	Net. Horiz.	α	β	γ	δ	Number Examined.
5	44	0	10	11·11	22·22	66·67	..	9
5	43	1	2	..	..	100·	..	3
7	32	0	0	100·	..	..	..	1
7	30	7	102	63·53	24·31	12·16	..	181
8	28	3	24	58·66	34·66	2·6	4·0	75
12	26	1	10	95·65	4·35	..	..	23
12	2	0	10	4·76	52·38	42·86	..	21
13	3	0	6	100·	..	..	..	3
13	5	1	0	50·	..	50·	..	2
25	27	2	26	66·67	8·33	12·5	12·5	24
27	Cove, W. 1½ miles.	0	30	2·13	2·13	46·81	48·93	47
27	Tod Head, W./N. 1½ mls.	0	16	60·	20·	20·	..	20

FEBRUARY 1908.

Date.	Station.	Net. V.	Net. Horiz.	α	β	γ	δ	Number Examined.
3	Cruden Speir, W.N.W.2m.	1	0	..	..	100·	..	1
17	28	1	598	94·11	3·22	2·64	..	1022
17	30	1	22	..	1·73	25·86	72·41	58
20	34	0	0	..	..	..	100·	1

FEBRUARY 1909.

Date.	Station.	1 m. ch. cl. V.	1 m. ch. cl. Surface Horiz. ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Total Examined.
3	28	13	388	78·78	15·53	5·13	·56	721
3	30	1	0	100·	..	..	..	2
3	32	1	0	100·	..	..	..	2
12	45	0	4	75·	25·	..	..	4
12	44	0	6	57·13	42·87	..	..	7
12	42	0	2	..	..	..	100·	1
17	5	0	2	100·	..	..	..	2
18	5a	0	1	..	50·	..	50·	2

FEBRUARY 1910.

Date.	Station.	1 m. ch. cl. V.	1 m. ch. cl. Surface Horiz. ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
3	Burghead, 50 miles.	0	6	88·9	11·1	..	..	18
3	Burghead, 15 miles.	0	0	71·44	14·28	14·28	..	7
4	28	1	4	78·12	21·88	..	..	32
5	Moray Firth, VII.	4	22	60·12	17·34	13·29	9·25	173
7	Berriedale.	0	18	8·69	50·44	56·54	4·35	23
10	Moray Firth, XVI.	0	0	..	100·	..	..	1
23	45	0	0	91·66	..	8·34	..	12
23	44	1	0	..	100·	..	..	1
23	43	0	0	..	..	100·	..	1
23	42	0	0	..	50·	50·	..	2
25	30	4	16	10·81	27·03	59·46	2·70	74

FEBRUARY 1911.

4	Firth of Forth, III.	0	0	..	100·	..	..	1
10	45	0	6	100·	..	..	..	8
10	44	0	2	..	100·	..	..	3
13	28	0	124	82·98	8·86	8·16	..	723
13	Moray Firth, IV.	0	3	66·7	33·3	..	..	3
13	Moray Firth, V.	..	44	95·35	4·65	..	..	43
14	Moray Firth, VII.	0	41	75·61	21·95	2·44	..	41

FEBRUARY 1912.

Date.	Station.	Haul. V.E.	Haul. 1 m. ch. cl. Surface ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
28	VIII. and IX. F. of Forth.	0	0	100·	..	..	..	4
29	V. Firth of Forth.	..	2	..	..	50·	50·	2

FEBRUARY 1913.

Date.	Station.	Haul. V. Hensen.	Haul. Horiz. H. Surface ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
20	Shiant Islands, W. ¾ S. 9½ m.	0	0	..	100·	..	..	1
26	Hoeness Point, N. 5½ mls.	0	14	87·5	12·5	..	..	8
27	Ru Stoer, E. ¼ S. 3 miles.	0	2	100·	..	..	..	2

MARCH 1905.

Date.	Station.	Haul. V.	Haul. Horiz. ½ Surf.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
8	Rattray Head, 3 miles.	..	1	..	..	100·	..	1
10	Bressay Lt., N./W. 2 mls.	1	68	74·5	13·2	7·2	5·1	318
18	Ramna Stacks, N. 1 mile.	..	4	11·1	..	22·2	66·7	9
20	Outskerry Lt., S.½E. 4 mls.	..	0	..	..	20·	80·	5
31	28	2	6	15·5·	5·9	21·7	56·9	459
31	29	4	758	51·9	35·8	12·3	..	762
31	30	0	8	19·1	9·6	39·7	31·6	136
31	31	1	14	60·	26·7	13·3	..	15
31	33	0	2	25·	20·	10·	45·	20

MARCH 1906.

Date.	Station.	Haul. V.	Haul. Horiz. ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Number Examined.
8	X., Moray Firth.	..	202	51·9	13·4	26·2	8·5	202
8	IX., Moray Firth.	..	201	46·8	14·9	33·8	4·5	201
14	Collieston, N.N.-W. 6′	..	20	10·	5·	60·	25·	20
15	VIII., Moray Firth.	..	224	49·2	41·5	9·3	..	224
15	Covesea, W.S.W. 10′	..	104	1·0	34·6	59·6	4·8	104
20	VII., Moray Firth.	9	144	68·8	19·8	10·8	·6	333
21	Helmsdale N.W./W.½W.6′	3	68	41·4	23·3	33·6	1·7	116
21	Lybster, N./W. ½ W. 4½′	1	4	53·3	26·7	13·3	6·7	15
21	Noss Head, N.W. ½ W. 3′	0	34	96·3	1·4	1·4	·9	137
21	Sinclair Bay.	2	14	62·5	12·5	16·6	8·4	24
21	Smith Bank.	8	170	2·3	40·8	55·8	1·1	353
21	Burghead, S./E. 3½ miles.	14	20	32·8	34·7	27·3	3·2	470
22	Lossiemouth, S.S.W., 3½ m	17	2450	51·5	32·8	15·2	·5	1766
22	Portknockie, S.S.W., 4 ms.	4	154	28·6	28·6	35·0	7·8	246
22	Troup Head, S.E., 3½ mls.	4	56	18·3	13·1	40·1	28·5	207
22	Kinnaird Deep.	3	40	·9	5·3	31·5	62·3	114
22	Dunrobin Castle.	..	118	21·2	34·7	37·3	6·8	118
27	IX., Firth of Forth.	1	10	63·6	36·4	..	..	11
28	VII., Firth of Forth.	0	3	100·	..	..	..	3
28	V., Firth of Forth.	0	3	66·6	33·4	..	..	3
28	II., Firth of Forth.	..	2	100·	..	..	..	2
29	I., Firth of Forth.	..	3	33·4	..	66·6	..	3
29	VI., Firth of Forth.	..	2	50·	..	..	50·	2
30	IV., Firth of Forth.	..	1	..	..	100·	..	1

MARCH 1907.

Date.	Station.	Haul. V.	Haul. Horiz. ½ hr. S.	Developmental Stages. Percentages. α	β	γ	δ	Total Examined.
7	VI., Dornoch.	..	348	95·3	1·2	1·6	1·9	596
8	Cromarty.	..	0	..	..	100·	..	1
11	Burghead Bay.	..	86	34·8	5·2	15·8	44·2	95
14	IX., Moray Firth.	..	116	30·3	18·4	38·0	13·3	376
21	Between Rattray Head and Kinnaird Head.	..	6	50·	..	33·3	16·7	6
23	Scarsheen Mts., N.W./N. 12 miles.	..	120	..	54·2	40·8	50·	120
28	May Island.	..	2	33·3	..	66·7	..	3

MARCH 1908.

Date.	Station.	Haul. V.	Haul. Surface ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Total Examined.
11	26	0	0	..	..	..	100·	1
12	Pentland Skerries, N. ½ E. 2 miles.	..	..	37·5	6·2	31·3	25·0	16
12	3	3	..	100·	..	..	..	3
12	5	1	14	..	18·5	66·7	14·8	27
15	7b	1	..	..	..	100·	..	1
16	27	0	4	7·1	..	57·2	35·7	14
16	Pentland Firth.	..	..	25·0	16·7	47·2	11·1	72
19	Troup Head.	1	12	37·5	6·2	25·0	31·3	16
20	XVI., Moray Firth.	1	12	7·7	15·4	69·2	7·7	13
24	Burghead Bay.	0	136	83·7	8·7	5·7	1·9	104
25	Dornoch Firth.	9	522	74·0	2·8	8·3	14·9	458
26	Sutors of Cromarty.	1	..	100·	..	..	..	1
26	X., Moray Firth.	5	120	39·3	6·1	35·2	19·4	165
27	VIII., Moray Firth.	8	140	50·0	6·4	41·4	2·2	140
	MARCH 1909.							
4	I., Firth of Forth.	0	6	62·5	25·0	12·5	..	8
4	II., Firth of Forth.	0	6	50·	16·7	33·3	..	6
5	VI., Firth of Forth.	0	2	25·0	12·5	62·5	..	8
5	V., Firth of Forth.	1	..	100·	..	..	..	1
23	Cove, W.N.W. 1′	0	0	..	..	50·	50·	2
23	Cove, W.N.W. 9′	0	26	20·7	34·5	34·5	10·3	29
23	Cove, W.N.W. 17′	0	12	11·1	66·7	22·2	..	9
23	Cove, W.N.W. 25′	0	4	33·3	..	66·7	..	3
24	Montrose, W.N.W. 33′	0	2	25·0	50·0	25·0	..	4
24	Montrose, W.N.W. 25′	0	12	53·8	..	38·5	7·7	13
24	Montrose, W.N.W. 17′	0	8	54·9	16·1	12·9	16·1	31
24	Montrose, W.N.W. 9′	1	0	16·7	16·6	41·7	25·0	12
24	Montrose, W.N.W. 1′	1	14	60·9	30·5	4·3	4·3	23
25	Kirkcaldy Bay.	0	0	33·3	66·7	..	..	3
26	May Island, E. 1 mile.	1	20	15·4	10·3	51·2	23·1	39
26	VII., Firth of Forth.	0	10	20·	10·	50·	20·	10
27	VI., Firth of Forth.	1	82	17·4	9·1	61·5	12·0	109
27	Pittenweem, N.E.½N.4½ m.	0	68	20·4	8·2	59·2	12·2	49
27	I., Firth of Forth.	0	0	100·	..	..	..	1

MARCH 1910.

Date.	Station.	Haul. V.	Haul. Surface ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Total Examined.
9	Tiumpan Head, S.W./S.½ S. 4′	0	0	100·	..	..	..	1
12	Arnish Point, N.W./N. 6′	0	18	18·2	81·8	..	..	11
14	Tiumpan Hd., W.N.W. 8′	0	4	33·3	66·7	..	..	3
19	Ru Rea, S. ½ W. 10′	0	0	..	..	100·	..	3
21	Bulgie Island, E.N.E. 7′	0	22	71·8	2·5	10·3	15·4	39
24	26	1	18	100·	..	..	..	13
25	2	0	12	..	..	..	100·	8
25	3	0	0	100·	..	..	..	2
25	5a	3	12	50·	25·	18·8	6·2	16
25	5b	0	6	22·2	22·2	33·4	22·2	9
29	27	0	0	..	..	100·	..	1

MARCH 1911.

Date.	Station.	Haul. V.	Haul. Horiz. ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Total Examined.
7	34	0	4	..	..	50·	50·	2
7	32	0	0	..	..	16·6	83·4	6
7	30	0	8	..	14·3	80·9	4·8	42
8	28	0	8	55·1	30·9	12·5	1·5	136
22	VIII., Firth of Forth.	..	..	25·0	..	75·0	..	4
22	IX., Firth of Forth.	..	..	100·	..	..	..	1
23	III., Firth of Forth.	0	2	..	20·	80·	..	5
24	II., Firth of Forth.	0	6	..	..	66·7	33·3	3
24	VI., Firth of Forth.	0	0	..	..	..	100·	1
24	I., Firth of Forth.	..	4	50·	..	50·	..	2
29	Bell Rock, S./W. 6 miles.	0	8	..	50·	33·3	16·7	6
29	Tod Head, W./S. ¾ S. 5 ms.	0	86	94·4	3·7	..	1·9	54
29	Stonehaven, W./N. ¼ N. 19′	3	38	43·1	8·3	37·5	11·1	72
29	57° N.; 1° 10′ W.	0	0	..	100·	..	..	2

MARCH 1912.

Date.	Station.	Haul. V.E.	Haul. Surface ½ hour.	Developmental Stages. Percentages. α	β	γ	δ	Total Examined.
7	20 m. E. of May Island.	1	18	98·2	1·8	..	..	57
7	Bell Rock, W./N. 15 miles.	0	4	20·	40·	20·	20·	5
7	Tod Head, N.N.W. 18′	0	6	..	20·	60·	20·	10
7	Tod Head, N.W./W. 13′	0	10	11·1	1·11	66·7	11·1	9
7	Girdleness, N.W/N. ¾ N. 13′	0	0	66·7	..	..	33·3	3
7	Girdleness, W./N. ¾ N. 10′	0	78	40·5	11·4	8·9	39·2	79

MARCH 1913.

Date.	Station.	Haul.		Developmental Stages. Percentages.				Total Examined.
		V Hensen.	Horiz. Surface ½ hour.	α	β	γ	δ	
8	Dunnet Head, S.E./E. 4½ miles.	0	18	43·5	4·3	34·8	17·4	23
8	Auskerry Light, W./N. ½ N. 6 miles.	0	0	100·	..	..	..	6
13	5a	0	6	..	..	80·	20·	5
24	VIII. and IX., F. of Forth.	0	18	87·5	12·5	..	..	16
25	V., Firth of Forth.	0	6	50	25·	25·	..	4
25	VI., Firth of Forth.	0	10	75·	25·	..	..	8

TABLE IV.—PLAICE LARVAE.

JANUARY 1905.

Date.	Position.	Apparatus.	Depth in Metres.	Number of Specimens in ½ hour.
25	Station 28.	Young fish trawl.	12	4
26	Station 30.	1 metre cheese-cloth.	5	7
,,	,,	,, ,,	10	6
,,	,,	,, ,,	20	7
,,	,,	,, ,,	28	22
	,,	,, ,,	56	1
,,	,,	Young fish trawl.	28	3
,,	,,	,, ,,	56	2
26	Station 31.	1 metre cheese-cloth.	..	2

FEBRUARY 1905.

24	Station 28.	1 metre cheese-cloth.	..	3
,,	,,	,, ,,	5	1
,,	,,	,, ,,	10	3
,,	,,	,, ,,	14	10
,,	,,	,, ,,	27	1
,,	,,	Young fish trawl.	14	2
28	Station 46.	,, ,,	31	1
7	Berriedale, N./E. 2½ miles.	1 metre cheese-cloth.	..	2
23	Station 44.	Vertical Haul. 1 metre cheese-cloth.	58	1

MARCH 1905.

Date.	Position.	Apparatus.	Depth in Metres.	Number of Specimens in $\frac{1}{2}$ hour.
10	Bressay Light.	1 metre cheese-cloth.	..	2
,,	,, ,,	,, ,,	20	1
20	Auskerry Light, S. $\frac{3}{4}$ E. 4 miles.	,, ,,	44	1
31	Station 28.	,, ,,	15	3
,,	,,	,, ,,	20	4
,,	,,	Young fish trawl.	..	3
,,	,,	,, ,,	10	3
,,	,,	,, ,,	20	3
31	Station 29.	Vertical Haul. 1 metre cheese-cloth.	53	2

MARCH 1906.

20	Tarbet Ness, W. 3 miles.	1 metre cheese-cloth.	50	2
21	Burghead Bay.	,, ,,	65	10
22	Troup Head.	Vertical Haul. 1 metre cheese-cloth.	55	1
22	,, ,,	,, ,,	27	8
,,	,, ,,	,, ,,	55	4
22	Kinnaird Head.	,, ,,	90	6
,,	,, ,,	,, ,,	180	4

MARCH 1907.

7	Dornoch Firth.	1 metre cheese-cloth.	13	2
26	Tod Head, N.W./N. 2 miles.	,, ,,	..	2
,,	,, ,,	,, ,,	19	8
,,	,, ,,	,, ,,	38	2

MARCH 1908.

25	Dornoch Firth.	1 metre cheese-cloth.	15	6
,,	,, ,,	,, ,,	31	20
26	Station X., Moray Firth.	,, ,,	70	30

MARCH 1909.

23	Cove, W. 1 mile.	1 metre cheese-cloth.	37	2
23	Cove, W. 9 miles.	,, ,,	87	12
24	Montrose, W. 1 mile.	,, ,,	..	2

MARCH 1910.

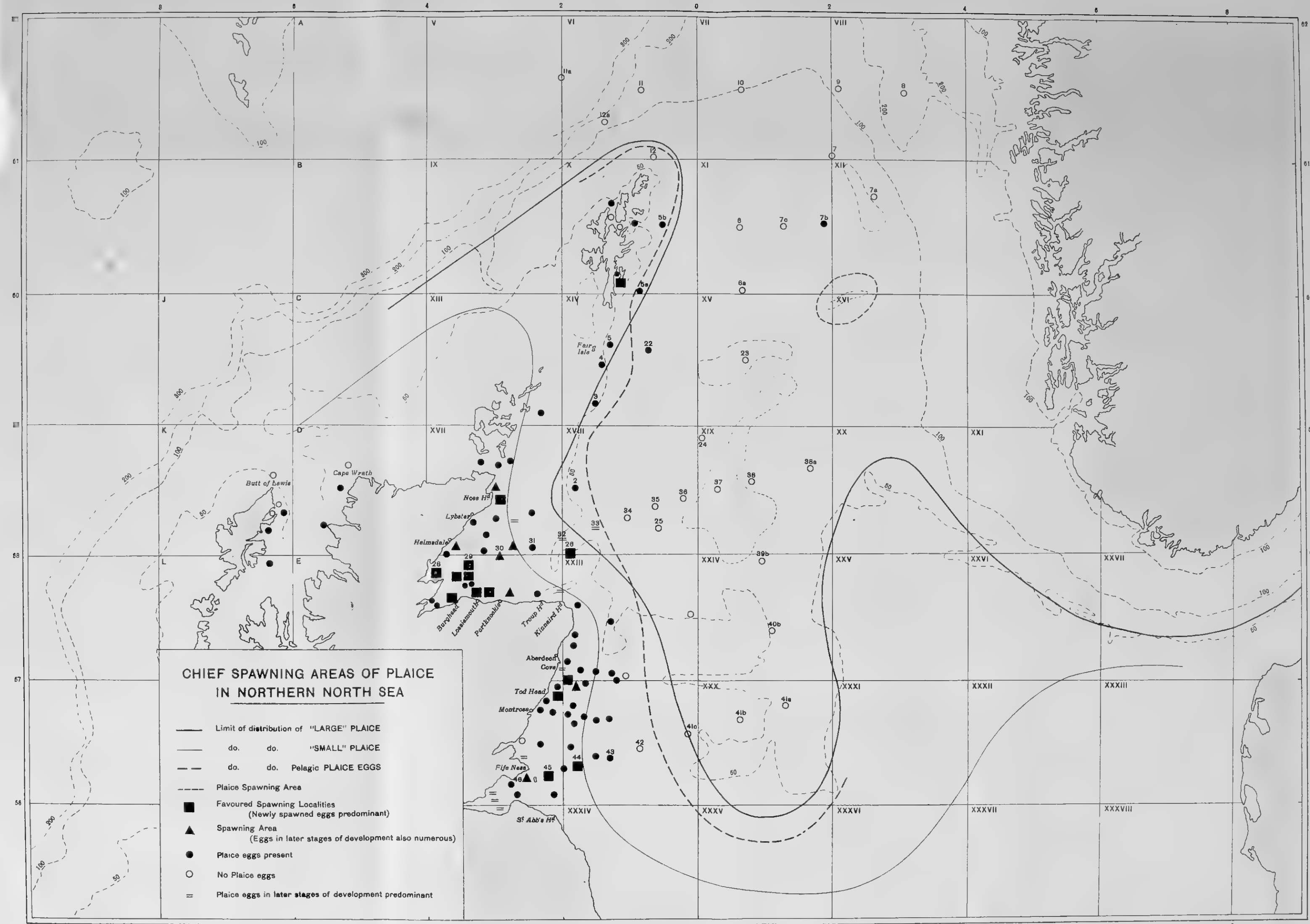
Date.	Position.	Apparatus.	Depth in Metres.	Number of Specimens in ½ hour.
29	Station 27.	1 metre cheese-cloth.	64	2

MARCH 1911.

7	Station 32.	Vertical Haul. 1 metre cheese-cloth.	78	4
,,	,,	,, ,,	. .	2
29	Bell Rock, S./W. 6 miles.	,, ,,	. .	2
29	Tod Head, W./S.¾S. 5 miles.	Young fish trawl.	. .	1
29	Stonehaven, W./N.½N. 19 m.	,, ,,	. .	1

MARCH 1912.

7	Girdleness, W./N.¾N. 10 m.	1 metre cheese-cloth.	37	4
,,	,, ,,	,, ,,	75	12



Ordnance Survey Office, Southampton, 1914.

FISHERY BOARD FOR SCOTLAND.

SCIENTIFIC INVESTIGATIONS,

1914.

No. III.

ABERDEEN FISHERY STATISTICS, 1913,

WITH AN INTRODUCTION BY

PROFESSOR D'ARCY W. THOMPSON, C.B.

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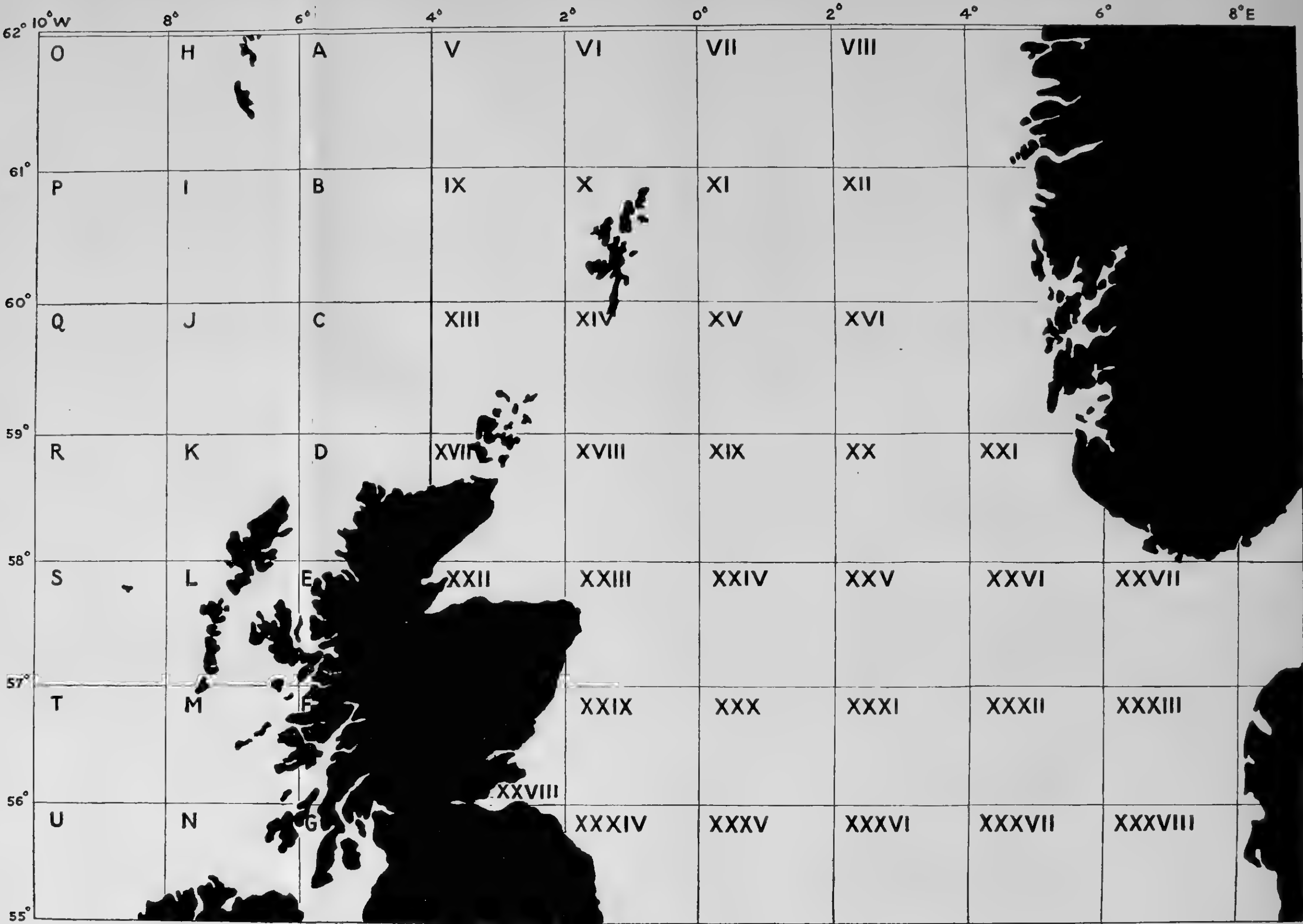

Chart showing the Areas (of one degree in latitude and two degrees in longitude) into which the North Sea and Western Waters are divided for statistical purposes.

ABERDEEN TRAWLING STATISTICS

FOR THE YEAR 1913.

INTRODUCTORY NOTE BY
D'ARCY WENTWORTH THOMPSON.

BEFORE entering, as usual, upon our annual survey of the detailed Statistics of the Aberdeen trawling fleet, let us glance briefly, on this occasion, at the General Statistics which throw light on the prosperity and growth of the port. In our First Report on Fishery and Hydrographical Investigations, published in 1905 (pp. 319–352), an account was given of the growth of the trawling industry of Aberdeen from its first beginning, by means of a single sailing trawler in 1874, and a single steam trawler in 1882; and statistical tables were printed, showing in detail the growth of the industry, year by year, from 1889–1904. Without again going into the whole question so fully as was done in that First Report, I may now, once more, epitomise the leading data, drawn from the Board's General Reports and Scientific Publications, in order to continue the history of the Aberdeen fishing industry down to the present time. For brevity's sake the figures for every third year only will be printed in the following tables.

TABLE A.

Number of Steam Trawlers employed from Aberdeen and in all Scotland.

	1892	1895	1898	1901	1904	1907	1910	1913
Aberdeen	86	76	94	179	178	194	217	236*
Scotland (total)	118	112	149	256	270	287	320	320
Aberdeen p.c.	73	68	63	70	66	68	68	74

* Not including 30 foreign trawlers, fishing more or less regularly from Aberdeen.

From the above Table it appears that the number of steam trawlers working from Aberdeen has just about trebled in the 21 years since 1892; and the same proportion is true for all Scotland, the Aberdeen boats standing, during the whole period, at not far from 70 per cent. of the whole. This threefold increase in number does not sufficiently indicate the increase of fishing power, for which it is not easy to find a standard of comparison. But we may safely say that the average tonnage, per vessel, has at least doubled (from 30 to 60 tons), and

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that the value of the fleet has increased about five times, from about £230,000 to over £1,000,000 at Aberdeen.

A curious and significant feature of the Aberdeen market during the last three or four years has been the great increase in number and importance of the German landings at the port. The German trawlers are all large vessels, well-found and well-manned, and their captains are men of more than average capacity. These vessels are employed for the most part in the Iceland fishery, with occasional voyages to the White Sea, the North Cape, etc., and the extent of their operations may be judged from the following Table :—

TABLE B.

Number of Trawlers, British and Foreign, landing at Aberdeen, during the year 1913, from Iceland, Faroe, and the White Sea.

	Iceland.	Faeroe.	White Sea.
British	37	389	..
German	529	..	26
Dutch	2	..	..

That is to say, while the Faroe trawl-fishery, as far as Aberdeen is concerned, is still in British hands, about 90 per cent. of the valuable Iceland trawl-fishery has passed into the hands of our German competitors. In other words, the Scottish trawl-master can no longer compete with the German in the more distant fishing-grounds. The following Table (C) illustrates the difference between the average returns per voyage from foreigners fishing on these distant fishing-grounds, and those from the common run of trips (both near and far) by Scottish vessels.

TABLE C.

Average Return, per Voyage, in Quantity and Value, of British and Foreign Trawlers, fishing from the Port of Aberdeen, 1913.

	No. of Landings.	Per Cent. of Total Number.	Total Quantity.	Per Cent. of Total Quantity.	Quantity per Voyage.	Total Value.	Per Cent. of Total Value.	Value per Voyage.	Price per Cwt.
			Cwts.		Cwts.	£		£	s. d.
British	11,499	95·1	1,659,640	76·0	144·3	1,023,012	85·4	89	12 4
Foreign	592	4·9	523,949	24·0	885·0	175,515	14·6	296	6 8

That is to say, while the foreign trawlers form less than one-twentieth part of the whole number landing at Aberdeen, they land close upon one-quarter of the whole amount of trawled fish landed at the port. The value, as is always the case with Iceland fish, is comparatively low, being just about one-half that of the general average, namely, 6s. 8d. as against 12s. 4d. per cwt. But even so, the return per voyage is nearly three and a half times greater in the case of the foreign

than in that of the British trawlers, and the total value of the landings by foreign trawlers is between one-sixth and one-seventh of the value of all the trawled fish brought into Aberdeen.

When we reviewed the statistics of the total landings of trawled fish at Aberdeen up to the year 1904, it was pointed out that the total quantity landed had increased nine-fold in the preceding 15 years, and had rather more than doubled every 5 years. So rapid a rate of increase could scarcely be expected to continue, and we now find that it has taken just the nine years, from 1904 to 1913, for the total landings of trawled fish at Aberdeen to be again approximately, but not quite, doubled; the quantity landed in 1904 was 1,280,000 cwts., and that in 1913 (including landings by foreign vessels) was 2,190,000. During the whole period, 1889-1913, that is to say in 24 years, the total quantity of trawled fish landed at Aberdeen has increased sixteen-fold, which rate of increase is obviously equivalent to a process of doubling every 6 years (Table D).

The total landings of all fish other than herring, sprat, etc. (that is to say of demersal fish), caught by line and trawl in all Scotland, have increased during the same period of 24 years from 1,345,000 to 3,296,000 cwts.—an increase of 145 per cent. This is equivalent to a process of doubling in 18·6 years.

[TABLE.

TABLE D.

Trawled Fish Landed at Aberdeen, in Cwts., 1889–1913.

Year.	Cod.	Ling.	Saithe.	Had-dock.	Whiting.	Total Round Fish.	Tur-bot.	Hali-but.	Lemon Sole.	Plaice.	Dabs.	Wit-ches.	Me-grims.	Total Flat Fish.	Skate.	Total Trawled Fish.
1889	7,946	247	1,118	69,253	477	79,058	3,760	23	9,750	28,676		..	..	42,209	920	137,193
1892	20,779	2,023	1,351	141,341	2,218	167,809	2,480	66	18,355	26,297		..	..	51,016	1,923	245,602
1895	53,486	4,107	1,281	223,373	2,953	285,285	2,095	818	15,424	35,304		..	..	57,690	2,838	356,412
1898	120,464	9,121	5,669	344,545	9,631	489,483	4,269	1,496	13,027	23,484	1,383	6,074	3,519	53,552	8,167	568,716
1901	148,134	41,704	21,576	549,573	71,623	832,694	3,007	5,921	13,250	22,522	1,996	35,507	17,234	98,943	21,541	990,630
1904	290,403	37,961	46,606	629,228	88,329	1,144,986*	3,517	8,968	14,861	38,172	1,799	23,312	10,200	101,327	31,094	1,279,656
1907	399,713	75,888	93,097	778,808	90,418	1,488,591	2,961	11,896	20,057	23,417	1,887	15,540	11,204	87,153	34,808	1,621,888
1910	576,922	66,152	135,117	580,461	99,591	1,514,416	2,077	11,040	31,012	21,305	3,099	12,192	16,075	96,971	45,389	1,665,240†
1913	867,152	85,981	327,014	496,711	147,246	1,991,489	1,709	13,313	27,058	19,747	2,053	26,746	16,112	106,929	57,936	2,189,818

* Given, by error, as 1,092,732 in the Table previously published (First Report, p. 321, 1905).

† Foreign landings from 1st October–31st December 1910 not included.

But the rate of increase has been vastly different in the different classes of fish. Dealing again with the Aberdeen trawl-fishery alone (Table D), we find that the landings of "round" fish—cod, haddock, etc.—have increased twenty-five fold since 1889, while those of "flat" fish—plaice, turbot, halibut, and the like—have only increased two and a half times. In the former the rate of increase is equivalent to doubling the catch every 5 years; in the latter, to doubling only every 18 years. Indeed, while the landings of round fish have steadily increased all the while, those of flat fish are scarcely larger in 1913 than in 1904, and were actually less in 1907 and 1910 than in that year, in spite of the great increase of the fleet and its catching power. But the difference becomes still more remarkable when we consider some of the separate species of fish. We see, for instance, that from 1889 to 1913 the landings of trawled haddock at Aberdeen have multiplied by seven, those of cod by more than one hundred, and those of ling, whiting, and saithe, by still greater amounts; the catch of cod has steadily increased, but that of haddock reached its maximum about 1907, and the catch in 1913 was only 63 per cent. of the catch of that year. Among the flat fishes, lemon sole has increased well-nigh steadily, though a slight falling off is at length apparent; the catch of 1913 is about three times that of 1889. The catch of halibut has increased enormously, and so has that of witches and megrims, all of which deep-sea fishes were landed in insignificant quantities at the beginning of our period. But plaice have diminished perceptibly, and turbot have decreased so considerably that the trawled catch of 1913 is less than half that of 1889.

Table E., which exhibits the percentage proportion of each fish in the Aberdeen trawling catch, illustrates with equal or greater clearness the same gradual changes. In 1889, while trawling was practically restricted to the inshore waters, the flat fish, principally consisting of plaice, constituted 30 per cent. of the entire catch. Now, when flat fish altogether constitute less than 5 per cent., the plaice itself constitutes less than 1 per cent. of the total trawler's catch. Cod has advanced from under 6 per cent. to close on 40 per cent., and has taken the place of haddock as the most important of all the trawled fishes. Haddock has fallen, in comparatively recent times, from constituting 50 per cent. or more of the catch, to under 23 per cent. On the whole, it is evidently the deep-sea fishes—cod, ling, saithe, and halibut—which have taken a larger and larger relative place in the total catch.

The steady growth in relative, as well as in actual, importance of the Aberdeen market is further illustrated by Table F. In this Table are compared the quantities of fish landed in Aberdeen, both by line and trawl, with the total quantities landed in Scotland—the herring fishery always excepted. We see that the total landings of trawl and line-caught fish at Aberdeen amount to no less than 73 per cent.—very nearly three-quarters—of the entire quantity landed in Scotland. In the case of several important fishes—ling, tusk, saithe, hake, and halibut—from 80 to 90 per cent. of the entire Scottish supply are landed at the port of Aberdeen.

Let us now consider, for a moment, the place which Aberdeen holds as a fishing port in comparison with the great English markets; and here we are of course dealing, as elsewhere in this article, only with

TABLE E.

Percentage (by Weight) of the several Fishes included in the Total Catch of the Aberdeen Trawlers, 1889–1913.

Year.	Cod.	Ling.	Saithe.	Haddock.	Whiting.	Eel.	Total Round Fish.	Turbot.	Halibut.	Lemon Sole.	Brill.	Plaice.	Witch Megrim.	Total Flat Fish.	Skate.	Other Kinds.
1889	5·8	0·2	0·8	50·5	0·3	0·012	57·6	2·7	0·02	7·1	..	20·9	..	30·8	0·7	10·9
1892	8·5	0·8	0·6	57·5	0·9	0·014	68·3	1·0	0·03	7·5	0·07	10·7	1·5	20·8	0·8	10·1
1895	15·0	1·2	0·36	62·6	0·9	0·03	80·0	0·6	0·23	4·4	0·08	9·9	1·1	16·2	0·7	3·0
1898	20·8	1·5	0·9	59·6	1·6	0·009	84·6	0·7	0·23	2·2	0·05	4·3	1·7	9·3	1·4	4·7
1901	15·0	4·2	2·2	55·5	7·2	0·01	84·1	0·34	0·6	1·4	0·05	2·4	5·3	10·0	2·2	3·7
1904	22·7	3·0	3·6	49·2	6·9	0·016	89·5	0·27	0·70	1·2	0·04	3·1	2·7	7·9	2·4	0·2
1907	24·6	4·7	5·7	48·0	5·6	0·022	91·8	0·18	0·73	1·24	0·012	1·44	1·7	5·4	2·1	0·7
1910	34·6	4·0	8·1	34·9	6·0	0·04	90·9	0·12	0·66	1·9	0·010	1·3	1·7	5·8	2·7	0·6
1913	39·6	3·9	14·9	22·7	6·7	0·03	90·9	0·08	0·61	1·2	0·008	0·90	2·0	4·9	2·6	1·6

NOTE.—The categories "Total Round Fish" and "Total Flat Fish" are not precisely identical in the earlier and later years, owing to certain fishes being at first more loosely classified among "Other Kinds." But in spite of this, the Table shows the general trend of things sufficiently well.

TABLE F.

Percentage Proportion of the Quantities of Fish Landed at Aberdeen (Line and Trawl) to the Total Quantities Landed in Scotland (Herring, Sprat, and Mackerel excluded).

Year.	Cod.	Ling.	Tusk.	Saithe.	Haddock.	Whiting.	Turbot.	Halibut.	Lemon Sole.	Plaice.	Skate.	Total.
1889	5·7	3·1	0·42	5·6	14·4	18·6	58·4	10·5	67·7	..	8·3	13·0
1892	12·7	9·6	6·1	8·2	24·7	19·1	54·6	45·7	78·6	..	15·9	21·1
1895	24·9	18·3	16·2	11·0	28·0	22·3	59·1	49·8	79·4	..	30·2	27·2
1898	36·8	28·6	27·8	13·2	49·6	42·2	68·9	64·9	73·4	..	45·4	42·1
1901	43·8	53·0	48·0	33·1	68·0	64·5	54·9	74·7	59·3	..	56·8	57·4
1904	52·6	68·2	69·1	53·2	62·5	62·9	51·2	84·3	55·8	60·0	68·0	59·8
1907	63·9	79·4	67·1	68·9	66·4	65·5	45·9	90·9	60·7	43·6	71·1	66·0
1910	64·3	74·3	73·5	65·1	63·4	67·0	41·7	89·6	70·1	42·9	72·9	65·1
1913	73·4	82·1	81·5	80·1	68·4	66·6	45·2	90·1	73·7	43·6	80·0	73·1

"demersal" or trawl and line-caught fish, and not at all with the great herring fishery. While in regard to the herring fishery Aberdeen is far outstripped by a great number of stations, both English and Scotch, it is only surpassed by one, namely, Grimsby, in regard to the quantity of its landings of demersal fish. And, as we have already seen, Aberdeen not only outstrips in this respect all other Scottish stations, but actually lands close on three times as much trawl and line-caught fish as all the rest of Scotland put together.

TABLE G.

Total Quantity of Demersal Fish landed at the Six Principal English Ports; showing also the Percentage Proportion relatively to the Catch at Aberdeen.

	1904		1907		1910		1913	
	Cwts.	Per cent.	Cwts.	Per cent.	Cwts.	Per cent.	Cwts.	Per cent.
Grimsby .	2,644,137	179·1	3,408,762	191·7	3,101,977	158·8	3,163,365	131·3
Hull . .	1,746,732	118·3	1,567,320	88·1	1,570,320	80·4	1,402,048	58·2
London .	968,319	65·6	1,177,802	66·2	1,100,539	56·4	956,775	39·7
Fleetwood.	295,227	20·0	600,366	33·8	739,724	37·9	678,474	28·2
N. Shields .	177,901	12·1	422,690	23·8	371,926	19·0	469,714	19·5
Milford .	333,660	22·6	514,984	29·0	449,111	23·0	426,739	17·7
Aberdeen .	1,476,697	(100·0)	1,779,463	(100·0)	1,952,912	(100·0)	2,408,865	(100·0)

The annexed Table (Table G), shows us the following, among other interesting facts. In the first place, while Aberdeen shows a steady increase in the landings of fish throughout the period, this is not the case with any of the English ports. In only one of the latter, namely, the comparatively new trawling-centre of North Shields, is the catch of 1913 greater than that of any of the earlier years. In all the other cases there is a distinct falling-off, dating usually from about 1907, or, as in the case of Hull, even earlier.

In 1904 Grimsby surpassed Aberdeen by nearly 80 per cent., and Hull did so by about 18 per cent.; in 1913, Grimsby was only 31 per cent. ahead of Aberdeen in the quantity of fish landed, while Hull only landed 58 per cent. of Aberdeen's quantity. The great port of Grimsby landed, in 1913, nearly 3,200,000 cwts. of (demersal) fish, a quantity almost precisely identical with that landed at al Scottish ports put together (3,300,000 cwts.). The two English ports next in order after Grimsby are Hull and London, and the quantity landed at Aberdeen was, as nearly as possible, equal to the landings of these two put together. If we exclude Hull, then next after London come Fleetwood, North Shields, and Milford Haven; and the Aberdeen landings are almost exactly equal to those of these four ports put together.

[TABLE.

TABLE H.

Percentage of Trawl-caught Fish to Total Supply of all kinds caught by Line and Trawl in Scotland, 1889–1913.

Year.	Cod.	Ling.	Tusk.	Saithe.	Haddock.	Whiting.	Eel.	Total Round Fish.	Turbot.	Halibut.	Lemon Sole.	Plaice, etc.	Total Flat Fish.	Skate.	Grand Total.
1889	4·7	0·8	..	2·7	15·5	7·2	1·7	9·7	80·1	0·4	97·7	57·0	53·2	6·3	13·5
1892	8·5	1·7	..	2·0	29·0	14·8	0·7	17·5	78·0	0·5	99·1	63·1	57·7	11·2	21·5
1895	18·4	2·8	..	1·8	33·7	12·9	0·7	24·4	85·7	2·9	98·9	65·1	56·9	8·3	26·4
1898	29·8	9·7	..	6·6	61·6	40·4	0·4	41·7	89·7	6·2	98·5	66·3	60·0	15·1	42·5
1901	48·6	30·4	..	30·3	85·0	80·1	0·8	65·6	92·0	18·4	99·6	79·9	70·7	31·3	65·6
1904	63·0	33·6	10·9	54·1	81·3	81·8	1·6	70·7	94·6	25·6	98·9	76·7	70·0	38·6	69·5
1907	71·0	57·0	20·5	74·5	84·2	88·2	3·4	78·0	94·6	32·1	99·2	79·3	71·6	45·1	76·4
1910	69·2	32·6	8·5	66·2	86·2	90·9	3·0	72·7	96·5	24·2	99·5	73·5	69·2	36·8	70·9
1913	77·3	43·1	13·6	81·4	88·4	94·0	3·0	78·9	97·9	30·3	98·4	66·7	70·7	46·9	77·1

Lastly, we may illustrate the growth of the trawling industry as a whole by the help of Table H, in which is set forth the percentage proportion of trawl-caught fish to the total supply from line and trawl —that is to say, to the total catch of "demersal" fish. This Table brings out several interesting facts. In the first place, it draws attention to the strong contrast between certain fishes which are and always have been caught almost entirely by the trawl, such as lemon sole and (though to a less extent) turbot; and others, such as conger-eel, which are and always have been caught almost wholly by line. Again, in other cases, we see how, five-and-twenty years ago, the trawling catch formed an insignificant, or almost insignificant, proportion of the whole, but has now come to contribute by far the greater proportion. This is true, for instance, of cod, saithe, and whiting. In yet other cases, such as ling, halibut, and skate, the trawl catch has progressively increased, forming a larger and larger percentage of the whole, but nevertheless the liners still furnish us with the greater part of the supply. And lastly, both in regard to the total catch and to each separate fish, we see more or less clearly how, during the period in question, the trawled catch increased at first comparatively slowly, then with greater and greater rapidity, until at length the rate of increase diminished or was arrested, and a condition of approximate equilibrium set in. There is, in fact, no longer, nor has there been for the last few years, a tendency for the preponderance of trawled over line-caught fish to go on increasing.

ABERDEEN TRAWLING STATISTICS

For 1913.

There are here presented, for the year 1913, the detailed returns of the Aberdeen trawling fleet, such as have hitherto been published, for the years 1902–1912, in the special Reports of the Board's North Sea Investigations. These returns are of two kinds.

In the first, and briefer, series of Tables is shown the catch of the entire trawling fleet, both British and foreign vessels, landing at Aberdeen. The British landings were 11,499 in number, the foreign 592, making a total of 12,091. For these voyages there are recorded the number of days that the vessel was absent from port, the gross earnings, and the quantity of fish landed of each kind and market class. These are further classified according to the place of fishing into the following regions :—

(1) Northern grounds, including areas VI.–XVI.
(2) East Coast grounds, including areas XVII., XXII., XXIII., XXVIII., XXIX.
(3) Middle grounds, including areas XVIII.–XXI., XXIV., XXV., XXX.
(4) South-eastern grounds, including areas XXVI., XXVII., XXXI.–XL.
(5) Various North Sea grounds, including catches made up from more than one of the above regions.
(6) Western grounds, off the north-west and west coasts of Scotland.
(7) Faroe and Iceland.
(8) Mixed grounds, to include catches made partly in the North Sea and partly on the western or northern fishing grounds.
(9) And lastly, the White Sea, Norwegian Coast (north of 62° N.), and other distant fishing-grounds.

Our first series of Tables, then, show (p. 30) for these larger areas—

1. The total number of voyages during the year, the total catch of each kind and class of fish, and the gross earnings of the entire Aberdeen trawling fleet.
2. The average catch and average earnings per voyage.
3. The average catch and earnings per day's absence from port.
4. The percentage yielded, by each of the above fishing-grounds, of the entire catch, and of each class of fish.

The second series of Tables (pp. 34–70) are based on a smaller number of voyages, in regard to which is received, by the kindness of

the owners and captains, full information as to the place of fishing and the number of hours spent in actual trawling. It is on this information that the Board depends for its knowledge of the variations in the average catch on each particular area from season to season and from year to year.

In the year 1913 the Board received such information from 10,388 voyages, or over 86 per cent. of the whole, leaving 1698 voyages whose place of fishing is only approximately ascertained, and for which the time spent in fishing is unknown. But out of these 10,388 voyages, in 1521 cases the vessel fished on more areas than one in the North Sea, and in 219 cases the vessel fished both within and without the North Sea. There are left, accordingly, 8648 voyages (or about 83 per cent. of all those included in the Board's general statistics) which yield us full information as to the catch per unit of time on some one particular ground. Accordingly, for these 8648 vessels the detailed Tables give the following information :—

5. For each area into which the North Sea and the waters adjacent to our Western coasts are divided for statistical purposes (areas covering one degree of latitude and two degrees of longitude) there are shown (*a*) the total number of vessels known to have fished in that area, month by month ; (*b*) the number of days during which they were absent from port ; (*c*) the number of hours actually spent in trawling.
6. The total catches of these vessels have not been printed in full, as was done in former years ; but, reducing these data to averages, there is shown, as formerly, for each month and for each area (*a*) the average catch, per 100 hours' fishing, of each kind and class of fish, and (*b*) the average earnings for the same unit of time.
7. Lastly, there is shown for each area, the mean monthly percentage of cod in the total catch of cod and codling, and of small haddock and small plaice in the total catch of those fishes.

Dealing firstly with the main body of statistics, there is shown, briefly, in the following Table (I.), the total quantities of trawled fish landed in 1913 by Aberdeen trawlers from the principal fishing-grounds.

[Table.

TABLE I.

Total Catch in Cwts. landed by Aberdeen Trawlers from the Principal Fishing-Grounds, 1913.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Per cent. 1913.	Per cent. 1912.
Northern Grounds	31,071	71,354	48,087	61,847	56,960	23,840	32,328	19,006	10,460	34,630	30,830	25,397	445,810	20·8	21·0
East Coast Grounds	13,967	16,676	22,867	19,869	18,278	24,437	34,692	36,095	31,565	24,843	16,838	19,436	279,563	13·1	14·9
Middle Grounds	30,341	14,736	9,903	6,449	2,214	9,008	30,837	29,166	23,163	24,708	26,790	54,257	261,572	12·2	11·9
South-East Grounds	..	462	286	..	..	..	1,893	8,206	16,595	12,205	5,075	380	45,102	2·1	2·1
Various North Sea	9,668	18,465	19,870	23,663	17,704	11,465	16,821	20,165	18,616	23,563	18,506	16,993	215,499	10·1	9·4
Total North Sea	85,047	121,693	101,013	111,828	95,156	68,750	116,571	112,638	100,399	119,949	98,039	116,463	1,247,546	58·3	59·3
Western Grounds	9,009	10,970	13,088	19,532	22,145	38,007	8,205	5,756	4,519	6,372	8,868	6,051	152,522	7·1	10·8
Faroe and Iceland	11,489	41,883	83,170	170,813	121,889	73,825	45,902	31,811	29,644	13,986	8,801	24,432	657,645	30·7	27·9
Mixed Grounds	1,765	2,875	2,835	6,948	5,763	8,315	7,542	4,521	2,873	6,462	3,398	1,011	54,308	2·5	1·8
White Sea	..	..	..	..	..	..	..	2,493	11,745	5,407	..	1,961	21,606	1·0	0·2
Norway	..	..	..	1,554	2,364	..	..	578	..	..	1,416	..	5,912	·3	0·0
TOTAL	107,310	177,421	200,106	310,675	247,317	188,897	178,220	157,797	149,180	152,176	120,522	149,918	2,139,539	99·9	100·0

The total trawled catch for 1913 is about 9 per cent. in excess of that of 1912 (Table II.). The landings from the East Coast, or "Near Grounds," are slightly diminished (by 4·4 per cent.), and those from the West Coast grounds show a more notable falling off (28 per cent.). From all other regions the catch is increased. The North Sea landings as a whole have increased by 7 per cent., and those from Iceland and Faroe, by reason of the large German landings already referred to, by no less than 20·5 per cent. The landings from the White Sea and Norwegian Coast, while still small, are four or five times greater than in the previous years.

TABLE II.

The Total Aberdeen Trawl-catch from the Principal Fishing Grounds ; Comparison between 1913 and 1912.

	1912. Cwts.	1913. Cwts.	Per cent. increase or decrease.
Northern Grounds	411,138	445,810	+ 11·4
East Coast Grounds	292,493	279,563	− 4·4
Middle Grounds	232,871	261,572	+ 17·4
South-East Grounds	41,095	45,012	+ 9·7
Various North Sea	183,831	215,499	+ 17·2
Total North Sea	1,161,428	1,247,546	+ 7·4
Western Grounds	211,366	152,522	− 27·8
Faroe and Iceland	545,702	657,645	+ 20·5
Mixed Grounds	35,455	54,308	+ 53·2
White Sea	4,366	21,606	+394·0
Norway	1,029	5,912	+474·0
TOTAL	1,958,439*	2,139,539	+ 9·2

* Including 93 cwts. from the Baltic.

The total catch from month to month follows, on a somewhat higher level, the same trend as in 1912 (Fig. 1). That is to say, there is as usual a well-marked maximum in the months of April and May, and a minimum about September or October. The former maximum is due, mainly, to the heavy landings of cod from Iceland in the months of spring.

[Fig. 1.

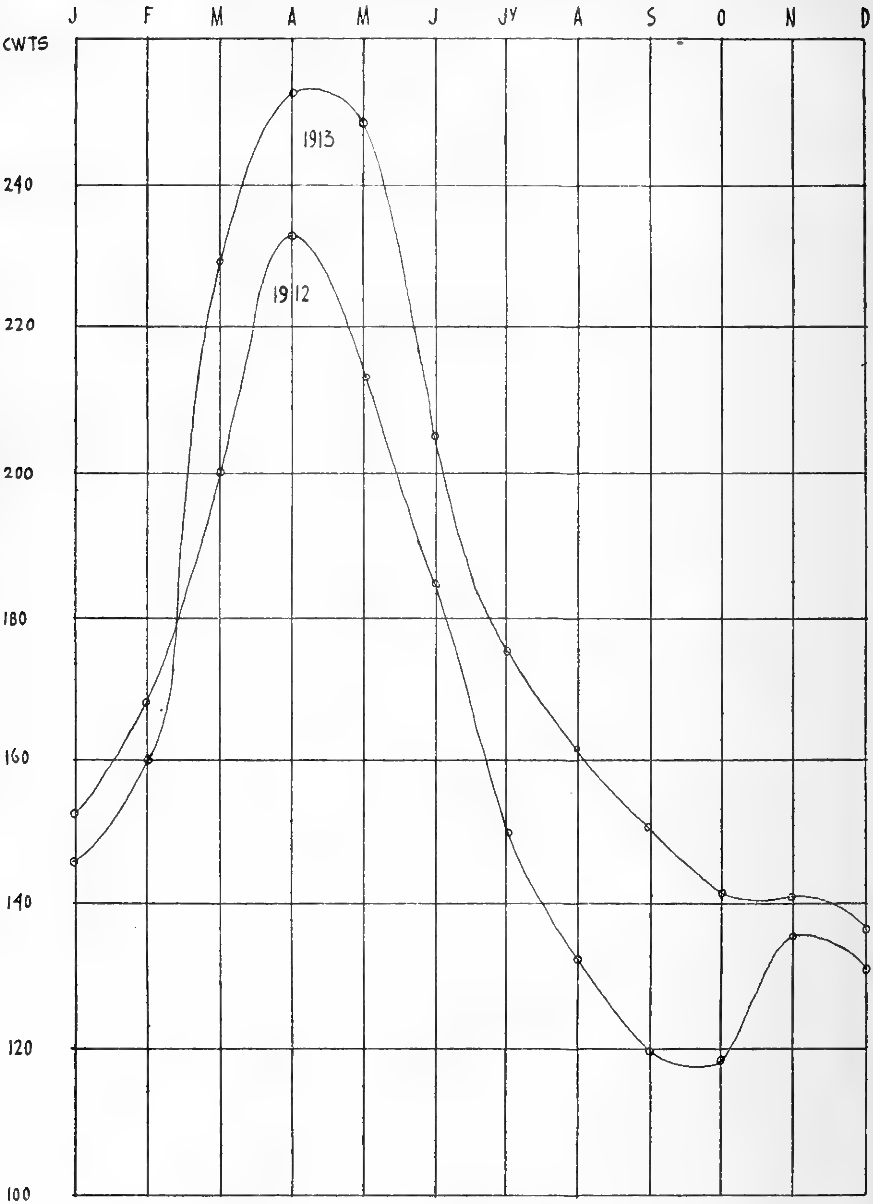

FIG. 1.—Total monthly landings of trawled fish in Aberdeen, 1912 and 1913 (smoothed curves).

In Table III. I show, in an abbreviated fashion, the average annual catch per voyage in cwts. of the whole Aberdeen fishing fleet, for the successive years 1905–1913; and in Table IIIA. the same results are shown for the successive triennial periods, 1905–07 to 1911–13.

TABLE III.

Average Total Catch in Cwts. per Voyage of Aberdeen Trawlers.

	1905	1906	1907	1908	1909	1910	1911	1912	1913
Northern Grounds . .	229·4	200·3	210·2	211·7	206·8	193·3	202·1	222·1	241·0
East Coast Grounds .	60·9	58·0	67·9	62·1	57·4	50·3	58·1	58·3	54·8
Middle Grounds . .	168·5	136·7	146·6	145·9	156·4	117·6	137·5	168·1	157·6
South-East Grounds .	163·2	149·4	180·3	199·8	111·8	141·4	245·2	203·4	170·9
Various North Sea . .	176·0	162·5	173·4	174·1	168·7	157·3	173·8	173·8	176·9
Total North Sea .	135·4	125·0	132·9	126·5	121·8	114·7	124·2	122·1	123·6
Western Grounds . .	177·3	159·3	183·8	201·2	199·1	192·5	190·8	210·4	211·9
Faroe and Iceland . .	518·9	687·9	569·6	717·4	692·6	666·8	801·0	733·4	685·9
Mixed Grounds . .	..	..	..	177·4	..	158·6	175·2	188·6	198·2
GRAND TOTAL .	153·6	154·9	169·2	161·0	149·0	148·8	164·5	170·9	177·0

TABLE IIIA.

Average Total Catch per Voyage of Aberdeen Trawlers ("Smoothed").

	1905-07	1906-08	1907-09	1908-10	1909-11	1910-12	1911-13
Northern Grounds. .	213·3	207·4	209·6	203·9	200·7	205·8	221·1
East Coast Grounds .	62·3	62·7	62·5	56·6	55·3	55·6	57·1
Middle Grounds . .	150·6	143·1	149·7	140·0	137·2	141·1	154·4
South-East Grounds .	164·3	176·5	164·0	151·0	166·1	196·7	206·5
Various North Sea .	170·6	170·0	172·1	166·7	166·6	168·3	174·8
Total North Sea .	131·1	128·1	127·1	121·0	120·2	120·3	123·3
Western Grounds . .	173·1	181·4	194·7	197·6	194·2	197·9	204·4
Faroe and Iceland .	589·1	655·3	659·9	692·3	720·1	733·7	740·1
GRAND TOTAL .	159·2	161·7	159·7	152·9	154·1	161·4	170·8

These last Tables, so far as they go, are on the whole encouraging. The average catch per voyage, over all the fishing-grounds taken together, was greater than in any previous year; and the same is true of the average for the Northern grounds and for the Western grounds. On the whole, taking the means of each successive period of three years (Table IIIA.), there is shown a tendency to gradual increase in the Faroe and Iceland catches also. There is a diminution in the average yield of the East Coast voyages, but the extent of this diminution is not very great. From the North Sea as a whole, though the average landing is considerably less than in the four years 1905–08, it is yet distinctly above the average of the next four years, 1909–12.

In the following Table (Table IV.), we show the average catch of certain particular fishes, per voyage, on the Northern, East Coast, and West Coast grounds, from 1905 to 1913.

TABLE IV.

Average Catch of Certain Fish in Cwts. per Voyage, 1905–13.

Northern Grounds.

	1905	1906	1907	1908	1909	1910	1911	1912	1913
Cod	17·7	17·2	17·6	17·4	19·1	24·5	26·7	27·9	30·8
Codling	14·2	12·6	11·2	21·6	30·1	30·3	31·8	30·8	33·5
Ling	14·8	12·9	14·0	12·6	12·9	11·1	11·1	12·3	21·3
Large & Ex.-Lge. Haddock	43·0	46·0	45·3	39·6	40·4	36·2	36·9	34·2	25·0
Medium Haddock	23·1	18·7	20·5	20·9	20·2	14·2	16·7	15·9	11·3
Small & Ex.-Sm. Haddock	34·4	34·1	44·5	48·3	38·4	22·8	26·2	29·2	21·4
Turbot	·16	·21	·19	·21	·25	·13	·16	·13	·12
Large Lemons	·74	·88	·93	·80	·91	·85	·94	·61	·42
Small "	·07	·19	·27	·40	·85	·97	·69	·44	·24
Large Plaice	·69	·73	·56	·24	·11	·04	·03	·03	·02
Medium "	2·47	2·00	1·81	1·19	1·06	·73	·64	·72	·48
Small "	·16	·13	·18	·15	·16	·06	·03	·10	·07
TOTAL	229·4	200·3	210·2	211·7	206·8	193·3	202·1	222·1	241·0
East Coast Grounds									
Cod	9·4	9·3	6·9	7·9	6·9	4·7	5·5	7·6	9·3
Codling	4·8	4·7	4·5	5·5	7·4	7·3	7·8	6·6	5·7
Ling	2·0	1·8	1·6	1·8	1·9	1·9	1·2	1·7	1·8
Large & Ex.-Lge. Haddock	6·4	4·3	5·7	5·5	4·5	3·7	2·6	2·8	2·0
Medium Haddock	4·1	3·2	6·9	5·4	4·2	2·6	3·2	3·5	2·4
Small & Ex.-Sm. Haddock	15·6	19·0	26·1	18·2	14·2	11·5	21·7	16·5	9·3
Turbot	·40	·42	·45	·43	·34	·24	·19	·18	·18
Large Lemons	2·5	2·9	2·5	2·8	2·5	2·5	2·2	1·9	1·7
Small "	·55	·66	·81	1·0	·9	1·3	1·5	1·5	1·2
Large Plaice	·14	·09	·07	·07	·07	·06	·04	·04	·04
Medium "	1·21	1·80	·91	1·19	1·13	1·24	1·10	1·16	·99
Small "	·17	·15	·12	·28	1·23	·49	·67	·64	·41
TOTAL	60·9	58·0	67·9	62·1	57·4	50·3	58·1	58·3	54·8
Western Grounds.									
Cod	36·9	36·7	26·2	30·2	26·1	36·0	56·8	57·3	51·4
Codling	12·4	15·7	10·8	15·0	23·3	33·0	34·9	32·6	29·2
Ling	3·3	3·2	6·8	10·5	9·4	7·35	6·8	7·9	10·6
Large & Ex.-Lge. Haddock	49·0	48·2	67·0	70·3	63·8	50·2	30·3	31·0	30·2
Medium Haddock	15·3	11·3	20·6	17·1	18·7	13·9	8·7	16·6	13·3
Small & Ex.-Sm. Haddock	20·5	13·0	21·6	25·3	21·0	13·5	17·6	24·5	16·5
Turbot	·69	·53	·37	·29	·24	·28	·18	·16	·23
Large Lemons	·83	·70	·62	·80	·64	·68	·98	·89	·65
Small "	·18	·17	·17	·25	·37	·44	·54	·61	·43
Large Plaice	1·80	1·59	1·08	·55	·27	·39	·38	·27	·21
Medium "	8·60	6·84	4·14	2·74	2·64	3·81	3·95	2·85	3·05
Small "	·53	·58	·35	·36	·59	·52	·91	·82	1·47
TOTAL	150·0	138·5	159·7	173·4	167·1	160·1	162·0	175·5	157·2

Here we recognise striking differences and even contrasts in regard to the progressive changes in the average catch of the different fishes, and it is especially remarkable that these differences are, for the most part, common to the three important regions illustrated in our Tables. Both on the Northern and Western grounds the average catch of cod has materially increased, while on the East Coast grounds, though it has fluctuated, it has not in the end perceptibly diminished. Large lemons have kept, on the whole, steady, though of late a tendency

to decrease is perceptible, and small lemons, after some years of more or less steady increase, now also show signs of diminution. But in regard to turbot, haddock, and plaice, there is distinct evidence of gradual diminution. In the case of turbot this diminution is not very conspicuous on the Northern grounds, but is marked both on the East and West coasts. Large haddock have steadily and seriously diminished. The decline in large plaice has been great and continuous, and the decline in medium plaice, though not so great, is very apparent on the Northern and Western grounds. Small plaice show many fluctuations and have been of late abundant in some regions, for instance on the Western grounds ; but elsewhere, and expecially on the Eastern grounds, they also have shown a tendency to diminish.

The following Table (Table V.), shows the number of voyages made to the several fishing-grounds in 1912 by the Aberdeen trawling-fleet, including the foreign vessels already referred to :—

[TABLE.

TABLE V.

Number of Voyages of Aberdeen Trawlers to the several Fishing-Grounds, 1913.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Percentage of Voyages.	Gross Earnings.	Percentage of Earnings.	Average Earnings per Voyage.
															£		£
Northern Grounds	151	261	228	200	225	106	122	87	53	141	134	142	1,850	15·3	256,493	21·4	139
East Coast Grounds	317	364	378	344	413	470	515	536	441	452	395	477	5,102	42·2	204,604	17·1	40
Middle Grounds	184	112	101	53	20	53	141	162	154	171	182	327	1,660	13·7	170,335	14·2	103
South-East Grounds	..	1	1	..	..	..	14	49	90	66	38	5	264	2·2	38,675	3·2	146
Various North Sea	54	104	99	100	96	69	91	119	123	135	116	112	1,218	10·1	132,298	11·1	109
Total North Sea	706	842	807	697	754	698	883	953	861	965	865	1,063	10,094	83·5	802,406	67·0	79
Western Grounds	49	53	65	64	106	172	43	31	22	30	46	39	720	6·0	96,648	8·1	134
Faroe and Iceland	32	59	115	185	125	96	99	59	72	36	24	57	959	7·9	253,548	21·2	264
Mixed Grounds	12	14	14	26	31	45	30	25	16	35	18	8	274	2·3	32,914	2·7	120
White Sea	..	..	..	..	..	..	..	3	14	6	..	4	27	·2	8,665	·7	321
Norway	..	..	..	3	7	..	..	1	..	..	1	..	12	·1	3,114	·3	260
TOTAL	799	968	1,001	975	1,023	1,011	1,055	1,072	985	1,072	954	1,171	12,086	100·0	£1,197,295	100·0	£99

TABLE VI.

Percentage of Total Number of Voyages of Aberdeen Trawlers to the various Grounds.

	1905	1906	1907	1908	1909	1910	1911	1912	1913	Mean.
Northern Grounds	20·3	23·1	24·7	24·0	24·0	27·6	27·4	16·1	15·3	22·5
East Coast Grounds	39·2	35·6	37·6	39·9	42·6	38·2	41·2	43·8	42·2	40·0
Middle Grounds	15·2	13·4	10·5	9·4	10·6	10·2	8·9	12·1	13·7	11·5
South-East Grounds	2·5	1·4	·7	·6	·6	·3	·7	1·8	2·1	1·2
Various North Sea	10·8	12·1	8·6	6·4	7·4	6·1	7·7	9·2	10·1	8·7
Total North Sea	88·0	85·6	82·2	80·2	85·1	82·5	85·9	83·0	83·6	84·0
Western Grounds	8·1	9·6	10·8	12·7	11·7	9·2	7·5	8·7	6·0	9·4
Faroe and Iceland	3·9	4·8	7·0	4·0	3·2	4·6	6·1	6·5	7·9	5·2
Mixed Grounds	..	..	..	3·2	..	3·7	1·5	1·6	2·6	1·4

We see that, out of a total of over 12,000 voyages, a little over 10,000 (or 83·5 per cent.) were made to the North Sea, while over 5000 of these were short trips to the "Near" or East Coast grounds. The North Sea contributed some 67 per cent. of the whole earnings of the trawling fleet, as compared with 68·7 per cent. in 1902. The relative proportion of voyages to the different areas was very much the same in 1913 as in 1912 (Table VI.), but there was a falling-off in voyages to the Western grounds (6 per cent., as against 8·7 per cent.), and a corresponding increase in the voyages to Faroe and Iceland (7·9 per cent. as against 6·5 per cent.). From Table VI. we see that during the last nine years the relative amount of fishing in the North Sea has remained remarkably constant, but there is of late rather less fishing on Northern grounds. Fishing on the Western grounds has diminished very considerably during the last six or seven years.

The average earnings per trip (Table V.) were distinctly higher than in the previous years (£99 as against £88), and in each separate region the average earnings per voyage were likewise, in greater or less degree, improved. The total earnings of the fleet were approximately 18 per cent. higher than in 1912.

But, as has been repeatedly explained in these Reports, the most important and the most practical lessons that are contained in our mass of detailed statistics are those which we learn by studying the average catch of each particular fish, on one area after another, month by month and year after year. It is in this way, and this alone, that we come to understand, firstly, the ordinary seasonal fluctuations, due mainly to migration, which each fish is subject to according to the locality; and, secondly, the changes in abundance over a long period of years that tell us whether or no this or that fish is showing signs of gradual diminution in abundance. It is not necessary that such questions should be reopened year after year for every single species of fish; it will be quite enough, as I explained in last year's Report, if we deal each year with three or four illustrative cases, and so gradually, in the course of a few years, overtake the whole. Last year

we dealt with the cod, the ling, and the witch; this year let us consider the hake, the saithe, the megrim, and the lemon sole. In all cases we shall limit our inquiry, more or less strictly, to the more important fishing-areas—that is to say, to those where the amount of fishing is so great as to furnish us with a practically complete statistical record, month by month, during the whole series of years since our investigations began.

The Hake.

In the following Table (Table VII.) are shown the average catches of hake, per hundred hours' fishing, in seven of our principal areas, the values given being the means for the period of eleven years, 1903–1913. No one of our trawl-caught fishes shows so clearly as the hake does a regular annual periodicity. On our coasts the catch of

TABLE VII.

Average Monthly Catch of Hake, in Cwts., per 100 Hours' Fishing, Aberdeen Trawlers, 1903–13.

Area.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
X.	3·2	·6	·6	1·1	1·8	1·0	1·2	5·1	59·2	**65·0**	32·2	8·4
XIII.	1·6	·2	·1	·1	1·1	8·0	**14·4**	5·0	6·0	15·9	**26·8**	6·7
XIV.	1·2	·3	·2	·4	1·0	3·2	3·3	5·7	11·6	**19·8**	18·8	7·7
XVIII.	·4	·3	·2	·1	·7	1·2	·9	1·2	3·1	8·3	**10·8**	3·7
XXIII.	·0	·0	·0	·0	·1	·4	·4	·5	·6	·6	**·8**	·2
C.	2·1	·0	·0	·0	·1	·2	·8	·4	1·1	3·8	**5·9**	·2
D.	2·6	·5	1·3	·2	1·7	**3·2**	1·8	·5	·3	**5·2**	1·5	2·2
The same numbers smoothed.												
X.	4·1	1·4	·8	1·2	1·3	1·3	2·4	21·8	43·1	**52·1**	35·2	14·6
XIII.	2·8	·6	·1	·4	3·1	7·8	**9·1**	8·5	9·0	16·2	**16·5**	11·7
XIV.	3·1	·6	·3	·5	1·5	2·5	4·1	6·9	12·4	**16·7**	15·4	9·2
XVIII.	1·5	·3	·2	·3	·7	·9	1·1	1·7	4·2	7·4	**7·6**	5·0
XXIII.	·1	·0	·0	·0	·2	·3	·4	·5	·6	**·7**	·5	·3
C.	·8	·7	·0	·0	·1	·4	·5	·8	1·8	**3·6**	3·3	2·7
D.	1·8	1·5	·7	1·1	1·4	**2·2**	1·8	·9	2·0	2·3	**3·0**	2·1

hake falls almost to nothing in the months of early spring, from February to April; and in all areas it rises to a maximum in early winter, about October and November. Only in the north-west of Scotland (Area D) are there indications, repeated from year to year, of a small temporary increase about June or July. The precise significance of this latter, and minor, movement is not known, but the main fact is clear, namely, that the hake, which is essentially a fish of the Atlantic coasts, comes round into the North Sea by way of the north of Scotland at the beginning of winter. If we look closely into the figures of Table VII. we shall see that, though the period of maximal abundance is nearly identical in all the areas referred to, yet it is just a little earlier in Area X. (Shetland), a little later in the two areas immediately to the southward thereof (XIII., XIV.), and again, in all probability, a few days later still in Area XVIII., still farther to the southward, off the mouth of the Moray Firth. The relative abundance of the hake varies from area to area in a similar way, that

is to say, the hake are caught in larger numbers in those areas to which they first come, and by the time we have got as far south as the Aberdeen coast (Area XXIII.), their numbers are very small indeed, though they are still enough to indicate a seasonal maximum, as in the other more frequented areas.

In Figures 2–5 are set forth the successive monthly catches during all the years for which we have information. Only four areas are here dealt with, for these are sufficient for illustration, and besides, in nearly all the others the total catch of hake is so meagre that the material at hand for such curves becomes inadequate. In Figure 2, for the Shetland area (X.), we have a beautifully regular curve, in which is at once seen how the catch rises every autumn, at almost precisely the same date, and how it falls in late winter to stand for several months at a value so low that we may regard it, comparatively speaking, as almost nil. We see, further, as a very marked feature of the diagram, that the catch was much higher in the years 1903–1905 (and especially in 1904) than in any of the succeeding years. There have been minor fluctuations during recent years, but there is no indication at all of a gradual and continued decline.

Figs. 3 and 4, dealing with Areas XIV. and XVIII., more and more to the southward of Area X., are highly interesting for comparison with that area, as just described. For it will be seen that they indicate precisely the same exceptional catches of hake in the 1903–05 as we have seen in Area X., and however convincing the statistics from any one area may be, it is always useful, and it helps greatly to assure us of the value of our statistical method, when we find the evidence furnished by one particular area to be repeated and confirmed by the independent observations in one or more adjacent areas. In these two latter areas, XIV. and XVIII., we see in the more recent years certain minor fluctuations which are not always identical in the separate areas, nor are they, perhaps, large and important enough to make us expect that they should be so; but both in Areas XIV. and XVIII. there is an indication of a catch considerably above the average in 1908. On the whole, the catches from 1906 onwards are characterised by very considerable regularity, and there is no appearance whatsoever of gradual impoverishment. Lastly, it will be observed that the actual magnitude of the catch diminishes steadily from Area X., through Area XIV., to Area XVIII.; that is to say, as we proceed southward along the line of migration and follow the comparatively small and dwindling body of hake, which enter the North Sea as an offshoot from the main Atlantic shoal. In the Western area, C. (Fig. 5), which includes Rona and Sule Skerry, the curve for hake is quite different from those just described, dealing with areas to the north-east of Scotland. In this case there is no sign of large catches in 1904 or 1905, but on the other hand there are large catches in the winter of 1907–08, and again, at the end of our period, in the years 1911–13. This, and also the fact that the annual date of the appearance of the hake is no earlier in this and the neighbouring Western areas than it is in Shetland and to the south thereof, would lead us to think that, whatever the precise route may be which the migrating hake follow, it is not such as would lead the fish close round the north of Scotland from the neighbourhood of the Minch to the neighbourhood of Shetland. The evidence, so far as it goes, rather entitles us to think that the

hake, coming in from farther to the westward, arrive almost simultaneously in these two regions, namely, the Shetland region and the region north of the Lewes, and that their course is directed in some years more abundantly to the one and in some years to the other.

The Saithe.

The saithe is another fish whose seasonal migrations are clear and regular, though it does not at any season desert our coasts so completely as the hake does. From Table VIII. (supplemented by some other data which I have not printed), we can trace the course of at least part of its annual migration. It comes to us from the north. At Faroe its season of maximum is in early spring, about the month of March, at which season the average catch per hundred hours' fishing

TABLE VIII.

Average Monthly Catch of Saithe, in Cwts., per 100 Hours' Fishing, Aberdeen Trawlers, 1903–13.

Area.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
X.	24·8	27·9	33·4	33·9	**50·7**	43·8	20·9	10·1	18·8	17·4	16·1	13·1
XIII.	23·4	9·4	6·6	17·6	23·5	**26·4**	18·9	6·6	13·1	20·1	19·4	**26·0**
XIV.	20·1	17·1	12·8	10·9	**51·8**	31·9	25·1	25·6	27·9	28·1	25·9	17·4
XVIII.	9·9	3·1	3·8	3·6	9·2	26·4	**42·2**	23·1	18·6	16·2	18·9	17·6
XXIII.	·9	·4	·6	2·5	2·9	4·2	**9·5**	7·6	6·1	3·0	2·0	1·6
D.	11·1	13·3	21·9	23·0	**24·9**	**24·9**	9·8	8·9	2·8	5·7	1·5	4·4
Faroe	12·3	43·9	**66·5**	56·2	23·7	27·0	24·3	30·6	16·1	11·7	15·8	8·4
Iceland	41·8	33·0	82·9	179·9	76·9	45·5	123·2	159·2	115·2	27·8	45·6	164·3
The same numbers smoothed.												
X.	21·9	28·7	31·7	39·3	**42·8**	38·5	24·9	16·6	15·4	17·4	15·3	18·0
XIII.	19·6	13·1	11·2	15·9	22·5	**22·9**	17·3	12·9	13·3	17·5	21·8	22·9
XIV.	18·2	16·7	13·6	25·2	31·5	**36·3**	27·5	26·2	27·2	27·3	23·8	21·1
XVIII.	10·2	5·6	3·5	5·5	13·1	25·9	**30·6**	28·0	19·3	17·9	17·6	15·5
XXIII.	1·0	·6	1·2	2·0	3·2	5·5	7·1	**7·4**	5·6	3·7	2·2	1·5
D.	9·6	15·4	19·4	23·3	**24·9**	19·9	14·5	7·2	5·8	3·3	3·9	5·7
Faroe	21·5	40·9	**55·5**	48·8	35·6	25·0	27·3	23·7	19·5	14·5	12·0	12·2
Iceland	79·7	52·6	98·6	**113·2**	100·8	81·9	109·3	**132·5**	100·7	62·9	79·2	83·9

has been (during the last eleven years) about 66 cwt. Around Shetland, and to the south thereof (Areas X. and XIV.), its maximal abundance is about the month of May, and the average catch in that month has been about 50 cwts. per hundred hours' fishing. The maximum is about the same season or a little later (May-June) on the North-western areas, C. and D., but here the catch is considerably smaller, and the same is true of Area XIII., to the northward of the Orkneys. It is June or July before the maximum is reached in our North-eastern and Eastern areas, XVIII., XIX., XVII., XXIII., and XXIX., and in the same order the magnitude of the average catches rapidly falls away. On the Aberdeen area (XXIII.), the average catch per hundred hours in July, the best month of the year, is under 10 cwts.; and in the area next to the southward, to the east of the Firth of Forth (Area XXIX.), the average maximal catch is only about 2 cwts. In some of our areas, especially XIII., and also at Iceland,

there are indications of a double maximum—in Iceland about March or April and again in August, in Area XIII. in early summer and again in late autumn; but if we have here, as is probably the case, some indication of a returning migration, our evidence is not yet complete enough to let us follow it in detail. Returning now to the curves (Figs. 6–9), which show the consecutive monthly catches from year to year, we find that in all the areas illustrated (X., XVIII., XXIII., C.), the line runs with almost monotonous regularity through the years 1903 to 1911, but in all cases there is a very marked increase in the catch of saithe in 1912 and 1913. The fact this fish is made more use of, and that there is a better market for it nowadays than formerly, is undoubted, and must not be forgotten; it may well be that, in consequence, considerable quantities of saithe are brought to market which a few years ago would have been thrown overboard. But all the same, this tendency to set greater store by the saithe is by no means so recent as 1912, and has been growing gradually for a good many years. The large catches indicated in 1912, and the still larger that are shown in 1913, are, undoubtedly, in my opinion, indications of a real state of exceptional abundance.

Of the flat-fishes, two, namely, the plaice and the witch, have been considered in recent Reports. We found in the case of both of these, and especially of the former, that there was ample evidence at hand to show that they had decreased in abundance during recent years. Let us now consider the megrim and the lemon sole, in neither of which have we the same proof of notable diminution.

The Megrim.

The megrim is a Northern fish, its headquarters with us being in the areas around Orkney and Shetland. The largest catches (Table IX.) are made in Area XIII., to the north of Orkney, and next in order comes the Shetland area (X.) and the group of areas (XIV., XVIII., XIX.) to the south and south-east of Shetland. Though an annual migration of megrims certainly exists, its course is not easily ascertained. It would seem that the season of maximal abundance in the Western areas, C. and XIII., is (as it also is in Faeroe) about December; February or March is the time of greatest concentration in the Shetland region and the areas south-east of Shetland. Farther to the south (Area XXIII.) and also farther to the east (XIX.), the maximum occurs in summer, about July, and in Area XVIII. there is a secondary maximum, or returning migration, about this period.

As it is only in a few areas that megrims are plentiful, so it is only from these few that we have statistical material sufficient for the drawing of our continuous curves (Figs. 10–13).

As regards small megrims, we see that in Area X. (Fig. 10) they were comparatively plentiful, much more so than for many years afterwards, in 1903 and 1904; but there is again some evidence of returning plenty in 1913. In Area XIII. (Fig. 12), which may be said to be the headquarters of the fish, we see considerable differences in abundance from year to year; but these fluctuations are irregular, and there is no sign whatever of that steady and gradual diminution which appears in the case of the plaice and of the witch. Much the same is true

of the large megrims (Figs. 11, 13); here also there is evidence, both from Area X. and Area XIII., that megrims were more plentiful about 1903 to 1905 than in later years, but here again the smaller catches of subsequent years show no sign of gradual or persistent diminution.

TABLE IX.

Average Catch of Large and Small Megrims, in Cwts., per 100 Hours' Fishing, Aberdeen Trawlers, 1903–1913.

Area.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
X. .	L.	4·7	3·6	4·4	**5·4**	4·3	1·1	·7	1·4	**5·2**	**5·2**	5·1	4·0
	S.	2·4	1·7	2·2	**2·7**	2·0	·4	·2	·8	2·8	**3·2**	3·1	2·8
XIII.	L.	6·7	3·8	3·5	1·8	1·7	1·5	5·4	4·1	4·8	4·4	7·7	**12·9**
	S.	5·2	1·4	1·3	·5	·2	·1	·9	1·0	1·2	2·4	4·0	**6·3**
XIV.	L.	1·4	2·2	**3·2**	3·0	1·3	1·1	1·4	1·5	2·0	2·3	1·7	1·7
	S.	·3	·5	**1·0**	·9	·4	·2	·1	·2	·4	·6	·5	·5
XVIII.	L.	2·9	5·3	**6·7**	2·5	2·4	4·3	3·5	3·9	5·3	4·6	3·1	2·4
	S.	·8	1·3	**2·5**	1·1	·6	·9	·6	1·0	1·7	1·2	·8	·4
C. .	L.	**2·5**	·9	·8	·9	·5	·4	·6	·8	·6	·8	1·4	1·2
	S.	·5	·3	·3	·4	·2	·1	·1	·2	·2	·4	**·7**	·5
Iceland	L.	·6	·3	·7	·1	3·1	2·6	**2·9**	**2·9**	1·4	1·5	1·6	1·4
The same numbers smoothed.													
X. .	L.	4·1	4·2	4·5	4·7	3·6	2·0	1·1	2·4	3·9	**5·2**	4·8	4·6
	S.	2·3	2·1	2·2	2·3	1·7	·8	·4	1·3	2·3	**3·0**	**3·0**	2·8
XIII.	L.	7·8	4·7	3·0	2·3	1·7	2·9	3·7	4·8	4·4	5·6	8·3	**9·1**
	S.	4·3	2·6	1·1	·7	·3	·4	·7	1·0	1·5	2·2	4·2	**5·2**
XIV.	L.	1·8	2·3	**2·8**	2·5	1·8	1·3	1·7	1·6	1·9	2·0	1·9	1·6
	S.	·4	·6	**·8**	·8	·5	·2	·2	·2	·4	·5	·5	·4
XVIII.	L.	3·5	**5·0**	4·8	3·9	3·0	3·4	3·9	4·2	4·6	4·3	3·4	2·8
	S.	·8	1·5	**1·6**	1·4	·9	·7	·8	1·1	1·3	1·2	·8	·7
C. .	L.	1·5	1·4	·9	·7	·6	·5	·6	·7	·7	·9	1·1	**1·7**
	S.	·4	·4	·3	·3	·2	·1	·1	·2	·3	·4	·5	**·6**
Iceland	L.	·8	·5	·4	1·3	1·9	**2·9**	2·8	2·4	1·9	1·5	1·5	1·2

The Lemon Sole.

The lemon sole is, in some ways, of particular interest to us. Though not nearly so valuable as the true, or black, sole, which is a southern fish and a stranger to the Scottish coasts, it is the most valuable of our ordinary flat-fishes. In the second place, it is especially plentiful close to the East Coast of Scotland, on the very grounds where our trawl-fishery is most diligently prosecuted; and thirdly, in spite of the amount of fishing to which it is subject, it keeps up its numbers remarkably well, and is in strong contrast to the plaice in this important respect. In all our coastal regions (Table X.), the period of maximal abundance of the lemon sole (at least of the large lemons) is in spring or summer, from March to August. Its maximal abundance is somewhat earlier (as will be seen from Table X.) on the Western areas, C., D., and XIII.; a little later in Area XVII., the region including the Pentland Firth; and, later still, in the Shetland area (X.), and also in Area XXIX., in which last the greatest catches on the average are obtained.

Small lemons were exceptionally abundant in Area XIV., to the

south of Shetland, as Fig. 15 shows, in 1909 and 1910. But on our Eastern areas, XXIII., and XXIX., they have shown a marked and almost steady increase during many years, and were markedly abundant in 1911, 1912, and 1913 (Figs. 17, 19).

TABLE X.

Average Monthly Catch of Large and Small Lemons, in Cwts., per 100 Hours' Fishing, Aberdeen Trawlers, 1903–13.

Area.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
X. .	L.	·54	·85	·81	·87	1·1	1·71	**1·79**	1·42	1·14	·81	·87	·64
	S.	·08	·3	·3	·17	·85	1·4	**1·44**	·99	·65	·5	·7	·3
XIII.	L.	·6	1·2	4·49	2·41	2·31	**3·53**	3·0	2·4	1·8	1·8	1·0	·45
	S.	·35	·39	1·49	·88	1·17	1·55	**2·53**	1·7	1·2	·8	·7	·4
XIV.	L.	·55	·7	·63	1·0	2·2	**3·85**	2·98	2·80	2·72	2·39	1·17	·75
	S.	·3	·3	·3	·43	2·0	**2·8**	2·37	1·69	·78	·6	·7	·6
XVII.	L.	3·64	4·18	3·7	5·4	**8·2**	7·1	6·98	**8·24**	8·0	3·9	3·27	4·3
	S.	1·27	1·38	1·1	1·4	**2·7**	2·2	2·29	2·43	2·6	2·1	1·97	2·3
XVIII.	L.	·84	1·05	1·43	2·99	2·58	2·44	**4·65**	2·73	2·5	1·57	·7	1·03
	S.	·3	·2	·33	·81	**1·06**	·65	·9	·5	·6	·4	·2	·38
XXIII.	L.	5·6	6·0	6·9	8·4	7·8	7·65	8·5	**8·7**	7·2	6·1	5·0	4·5
	S.	1·9	2·1	2·4	2·7	3·0	3·5	**3·9**	3·7	**3·9**	3·8	3·4	2·0
XXIX.	L.	5·9	5·4	5·24	6·7	9·0	10·2	**10·4**	10·2	8·7	8·3	6·8	6·0
	S.	1·8	1·3	1·9	1·5	1·7	2·5	2·5	2·6	2·3	2·4	2·7	2·0
C. .	L.	·71	1·0	**1·57**	1·15	·9	·9	1·02	·8	·8	·55	·6	·9
	S.	·25	·29	·53	·3	·4	·5	·48	·4	·8	·46	·4	·5
D. .	L.	1·3	1·87	3·96	**4·69**	1·61	1·85	1·9	1·0	·99	1·03	1·39	1·36
	S.	·7	·69	·96	**1·38**	·54	·83	·8	·7	1·0	·8	1·23	·73
Faroe	L.	5·73	8·2	8·0	8·4	8·6	8·6	6·7	5·0	6·7	5·1	3·49	9·8
	S.	·54	·7	·8	·9	1·1	1·3	1·2	1·1	1·15	1·1	·92	1·1
Iceland	L.	·4	·4	·3	1·83	**4·52**	2·31	3·11	1·74	·82	·65	·8	·2

The same numbers smoothed.

Area.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
X. .	L.	·68	·73	·84	·93	1·23	1·53	**1·64**	1·45	1·12	·94	·77	·68
	S.	·23	·23	·26	·44	·81	1·23	**1·28**	1·03	·71	·62	·50	·36
XIII.	L.	·75	2·1	2·3	**3·0**	2·7	2·9	**3·0**	2·4	2·0	1·5	1·1	·68
	S.	·38	·74	·92	1·18	1·20	1·75	**1·93**	1·81	1·23	·90	·63	·48
XIV.	L.	·67	·63	·78	1·28	2·35	3·01	**3·21**	2·83	2·64	2·09	1·44	·82
	S.	·4	·3	·31	·91	1·74	**2·39**	2·28	1·61	1·02	·69	·63	·5
XVII.	L.	4·04	3·84	4·43	5·77	6·90	7·43	7·44	**7·74**	6·71	5·06	3·82	3·74
	S.	1·65	1·25	1·29	1·73	2·10	2·39	2·31	**2·44**	2·38	2·22	2·12	1·85
XVIII.	L.	·97	1·11	1·82	2·33	2·67	3·22	3·27	**3·29**	2·27	1·59	1·10	·86
	S.	·3	·3	·45	·73	·84	**·87**	·68	·66	·5	·4	·3	·29
XXIII.	L.	5·37	6·2	7·1	7·7	7·95	7·98	**8·28**	8·13	7·33	6·10	5·20	5·03
	S.	2·0	2·1	2·4	2·7	3·1	3·5	3·7	**3·8**	**3·8**	3·7	3·1	2·4
XXIX.	L.	5·8	5·51	5·78	6·98	8·6	9·8	**10·3**	9·8	9·1	7·9	7·0	6·23
	S.	1·7	1·7	1·6	1·7	1·9	2·2	**2·5**	**2·5**	2·4	2·4	2·4	2·2
C. .	L.	·87	1·09	**1·24**	1·20	·98	·94	·90	·87	·72	·65	·68	·74
	S.	·35	·36	·37	·41	·40	·46	·46	**·56**	·55	·55	·45	·38
D. .	L.	1·51	2·38	**3·51**	3·42	2·72	1·79	1·58	1·30	1·01	1·14	1·26	1·35
	S.	·71	·78	**1·01**	·96	·92	·72	·78	·8	·8	**1·01**	·92	·89
Faroe	L.	7·9	7·3	8·2	8·3	**8·9**	7·96	6·8	6·1	5·6	5·1	6·1	6·3
	S.	·78	·68	·8	·9	1·1	**1·2**	**1·2**	1·15	1·12	1·06	1·04	·85
Iceland	L.	·3	·36	·84	2·2	2·89	**3·31**	2·39	1·89	1·07	·7	·55	·5

Large lemons show a certain amount of diminution in the Shetland area (X.) of recent years (Fig. 14), as compared with the years 1904–07. But in Areas XIV., XXIII., and XXIX., from Shetland southwards to the Firth of Forth, our curves give the impression of remarkable steadiness, the seasonal waves of abundance recurring year after year in an almost symmetrical fashion. In Area XIV. (Fig. 16) there is a tendency to drop in the last years of our series, and in Area XXIII.

(Fig. 18) a tendency of the same kind, but less marked, may be detected. It still remains true, however, that in comparison with the marked and indubitable decline which the catches of plaice and witch have undergone, our statistics in the case of the lemon sole show good evidence of a satisfactory maintenance of the supply.

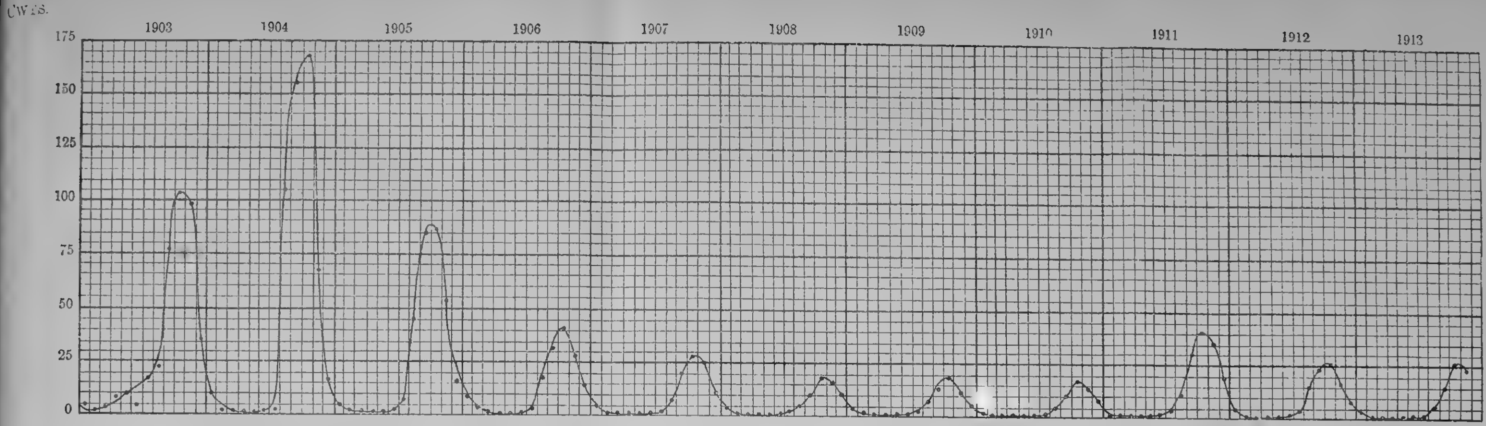

Fig. 2 Mean Monthly Catch of Hake in Cwts. per 100 Hours' Trawling in Area X (Smoothed Curve)

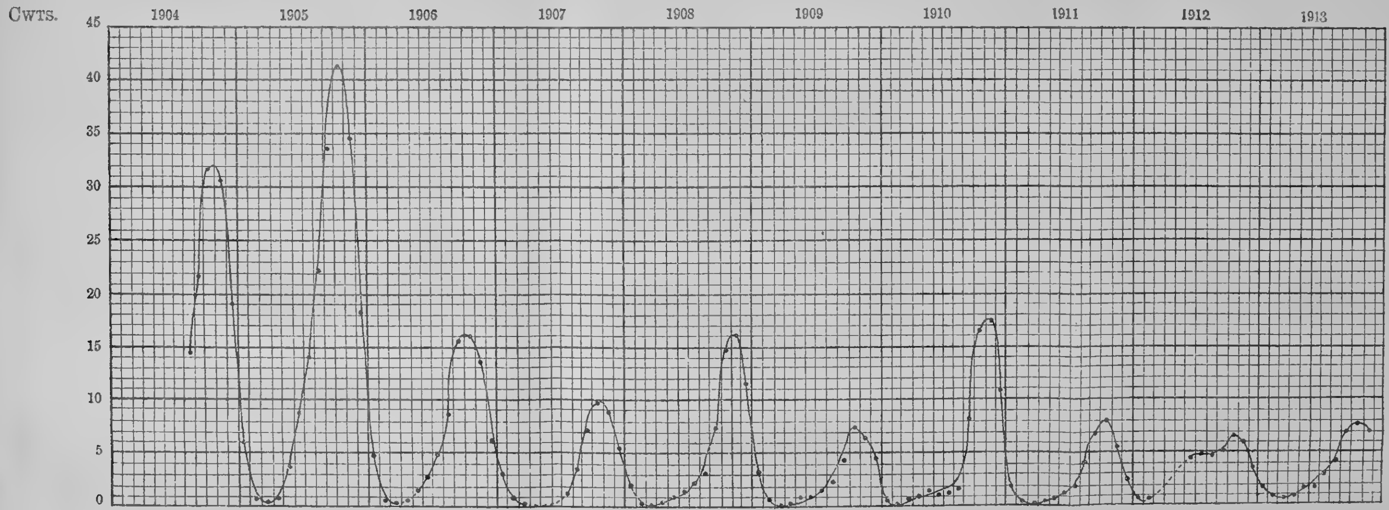

Fig. 3 Mean Monthly Catch of Hake in Cwts. per 100 Hours' Trawling in Area XIV. (Smoothed Curve)

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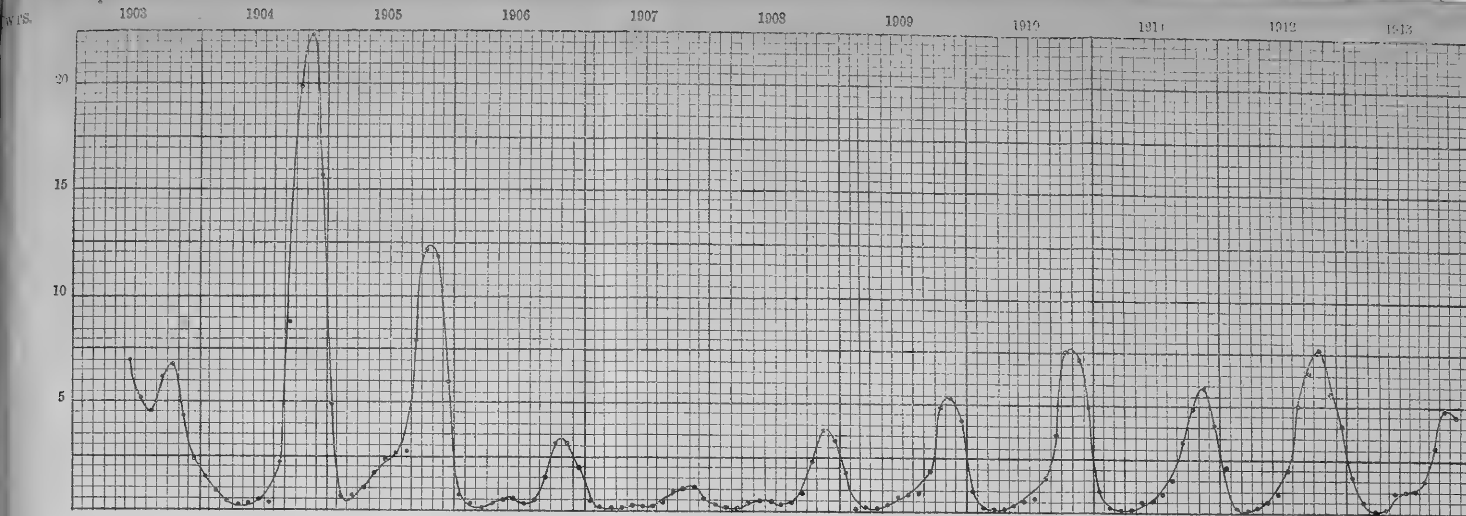

FIG. 4 MEAN MONTHLY CATCH OF HAKE IN CWTS. PER 100 HOURS' TRAWLING IN AREA XVIII. (SMOOTHED CURVE)

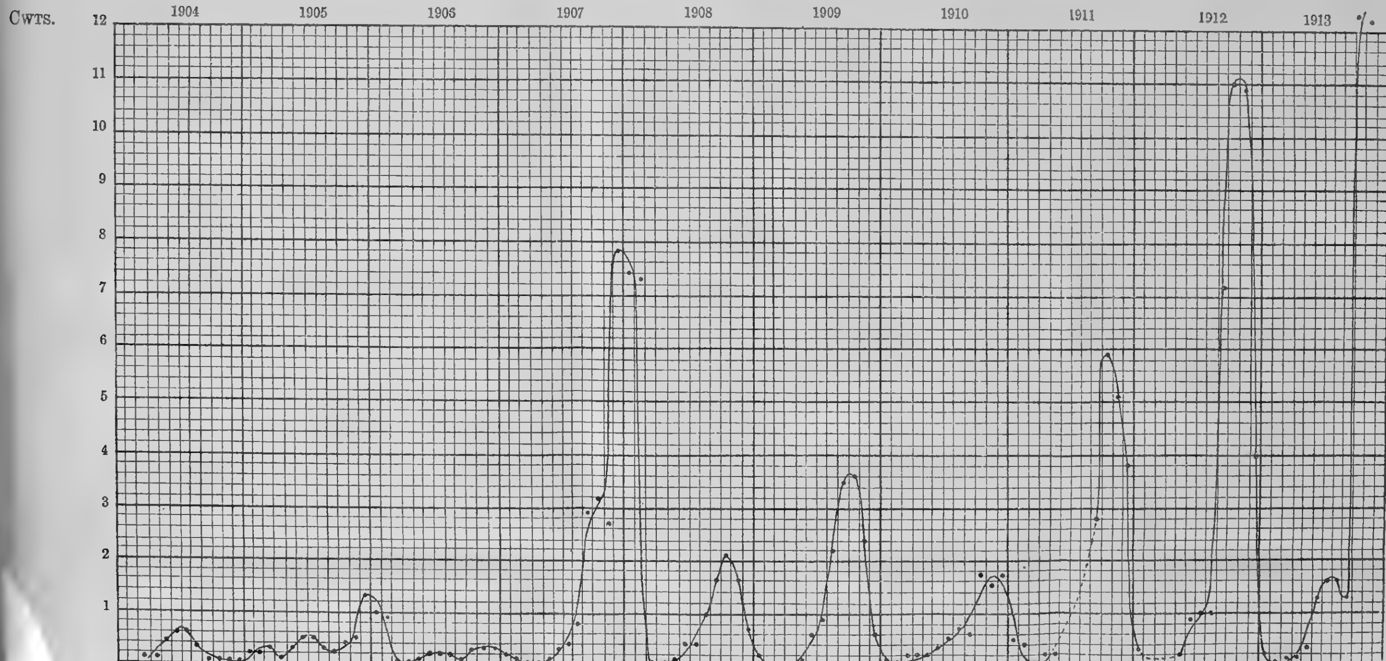

FIG. 5 MEAN MONTHLY CATCH OF HAKE IN CWTS. PER 100 HOURS' TRAWLING IN AREA C. (SMOOTHED CURVE)

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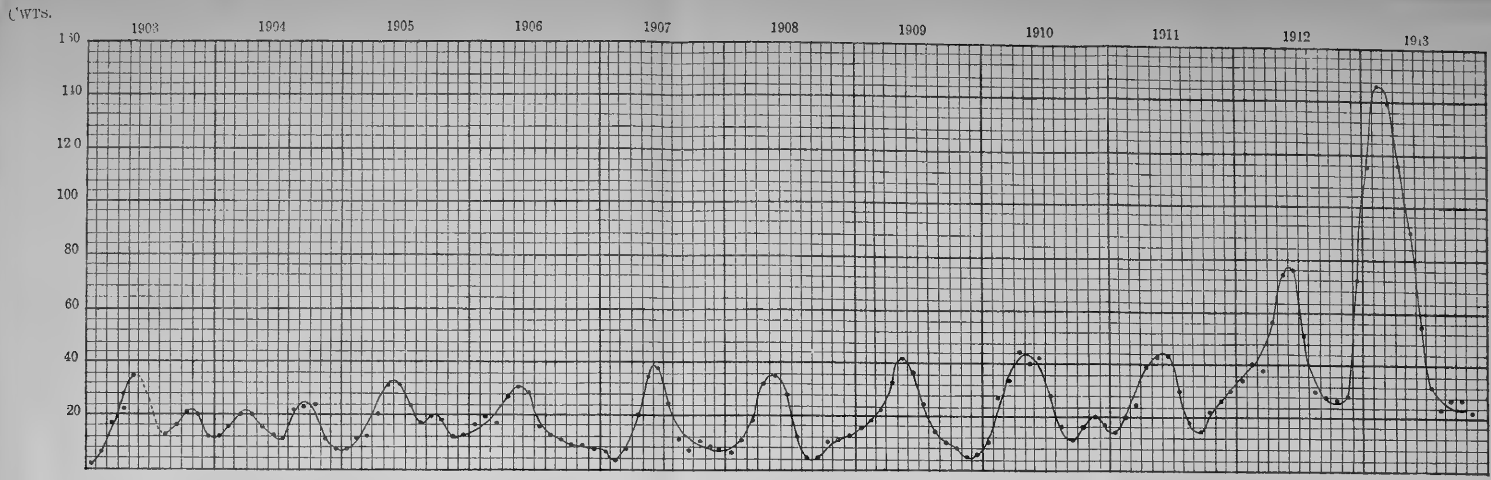


FIG. 6 MEAN MONTHLY CATCH OF SAITHE IN CWTS. PER 100 HOURS' TRAWLING IN AREA X. (SMOOTHED CURVE)

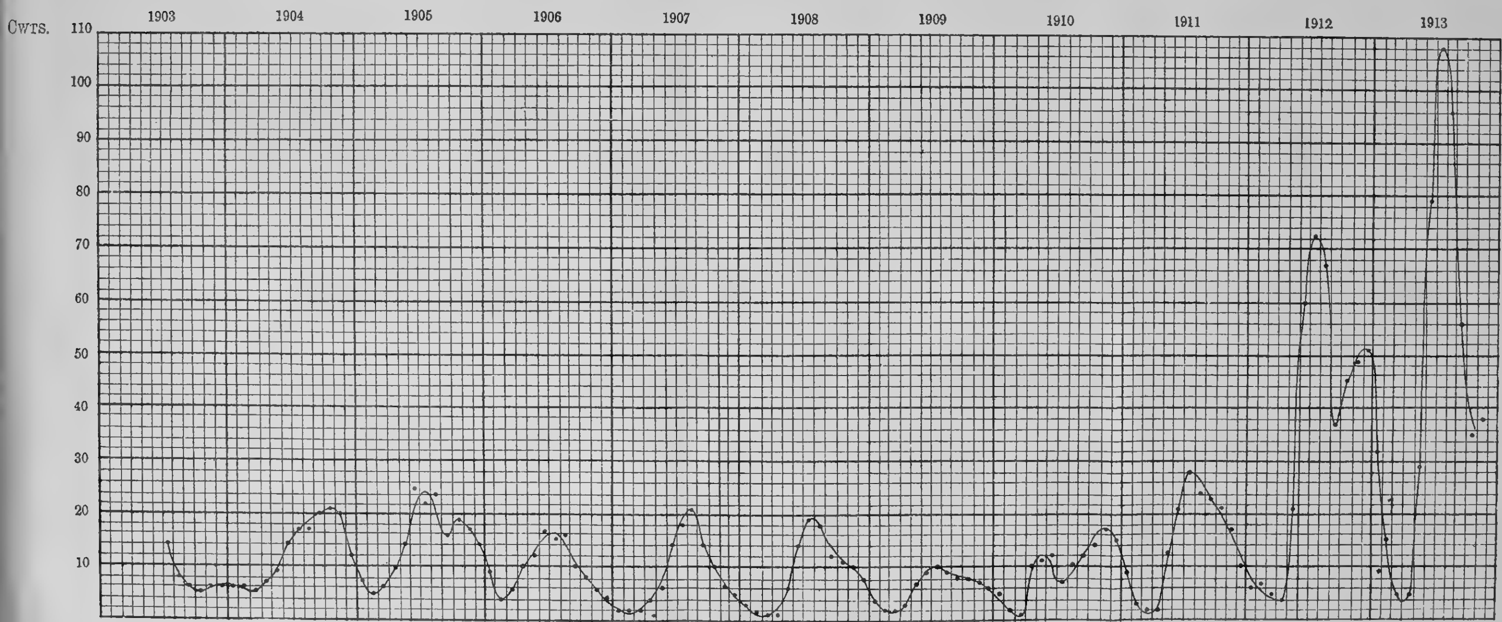


FIG. 7 MEAN MONTHLY CATCH OF SAITHE IN CWTS. PER 100 HOURS' TRAWLING IN AREA XVIII. (SMOOTHED CURVE)

Wt 1505-14 500 10/14 M'F & E

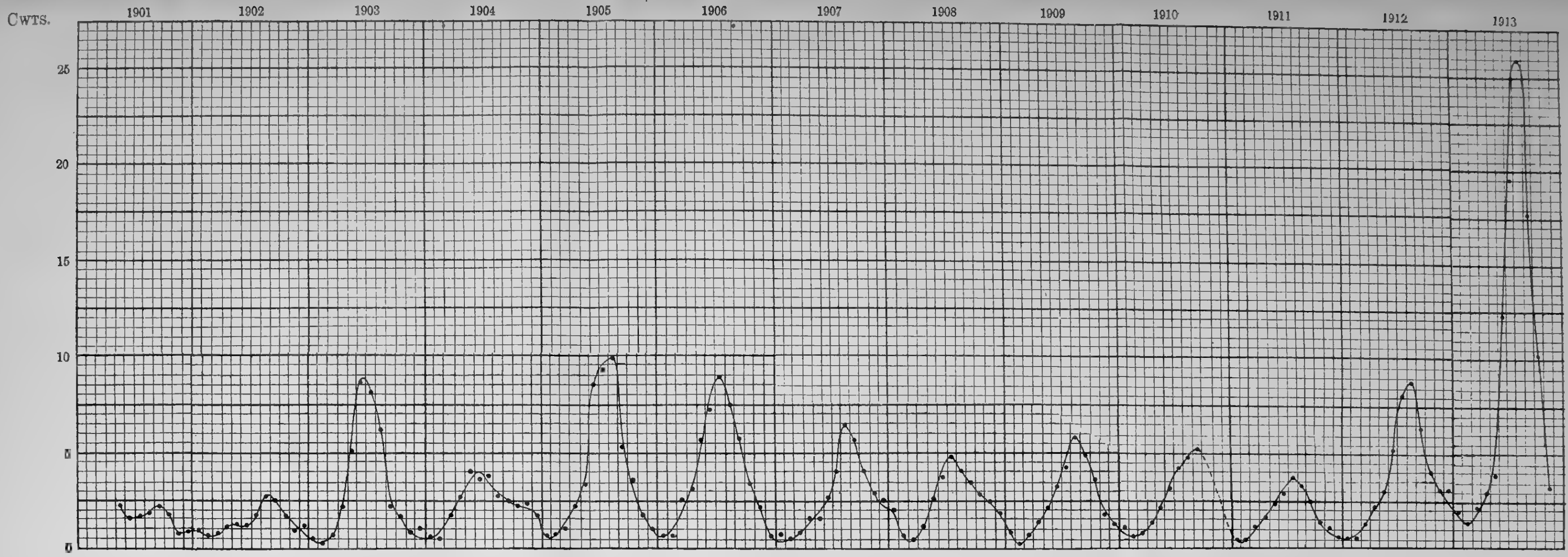
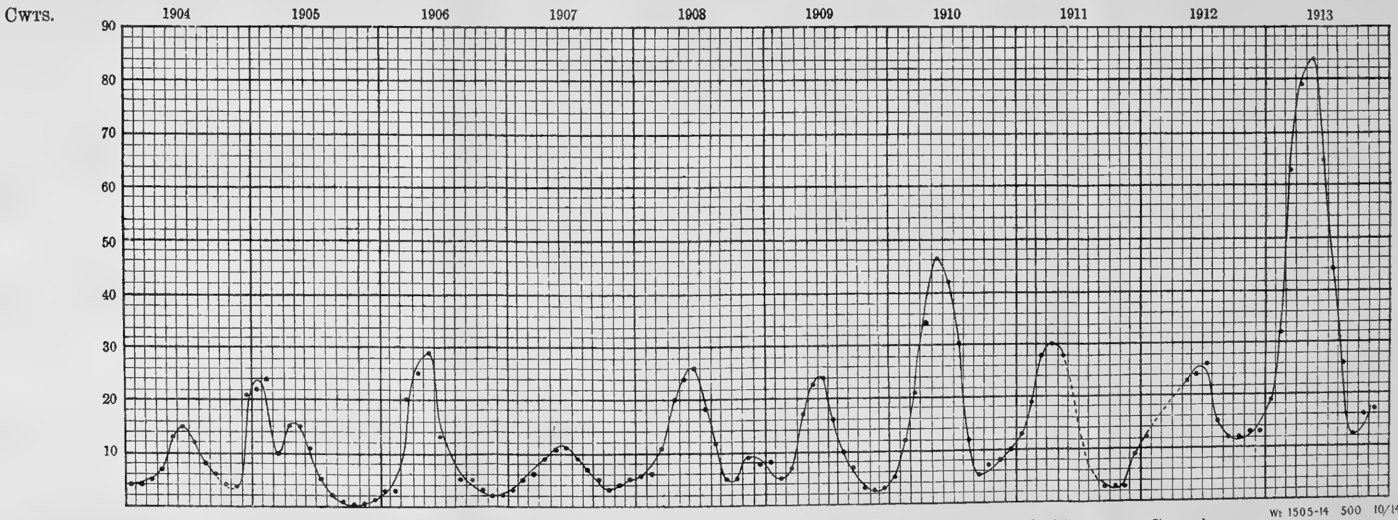


Fig. 8 Mean Monthly Catch of Saithe in Cwts. per 100 Hours' Trawling in Area XXIII. (Smoothed Curve)



Wt 1505-14 500 10/14 M'F & E

Fig. 9 Mean Monthly Catch of Saithe in Cwts. per 100 Hours' Trawling in Area C. (Smoothed Curve)

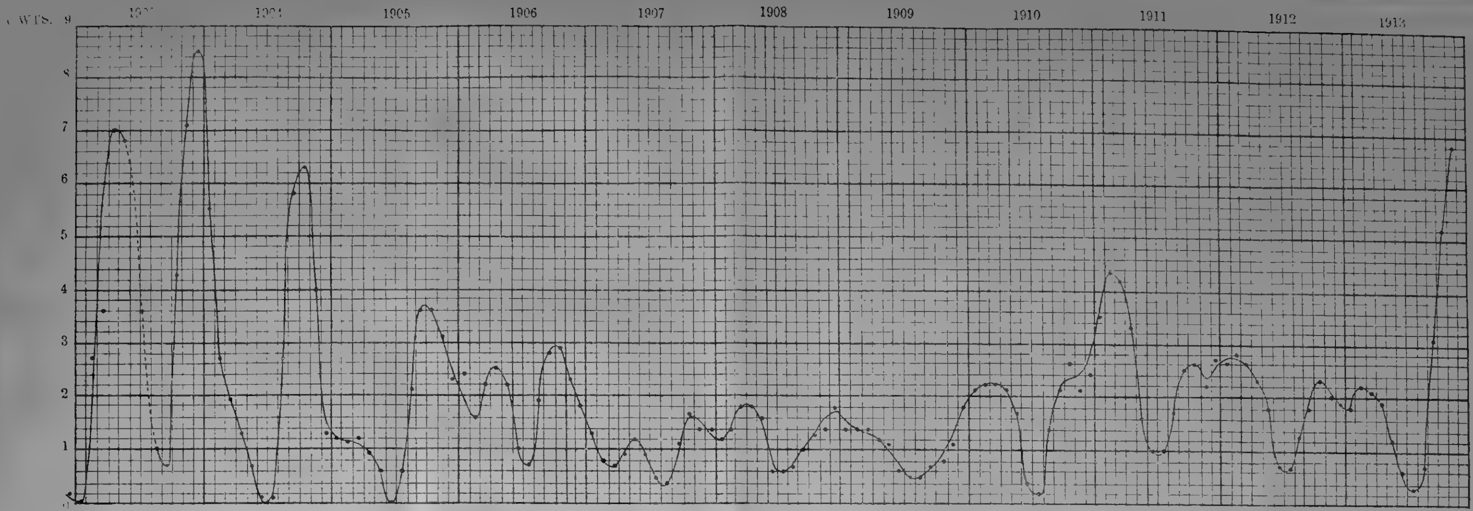


FIG. 10 MEAN MONTHLY CATCH OF SMALL MEGRIMS IN CWTS. PER 100 HOURS' TRAWLING IN AREA X. (SMOOTHED CURVE)

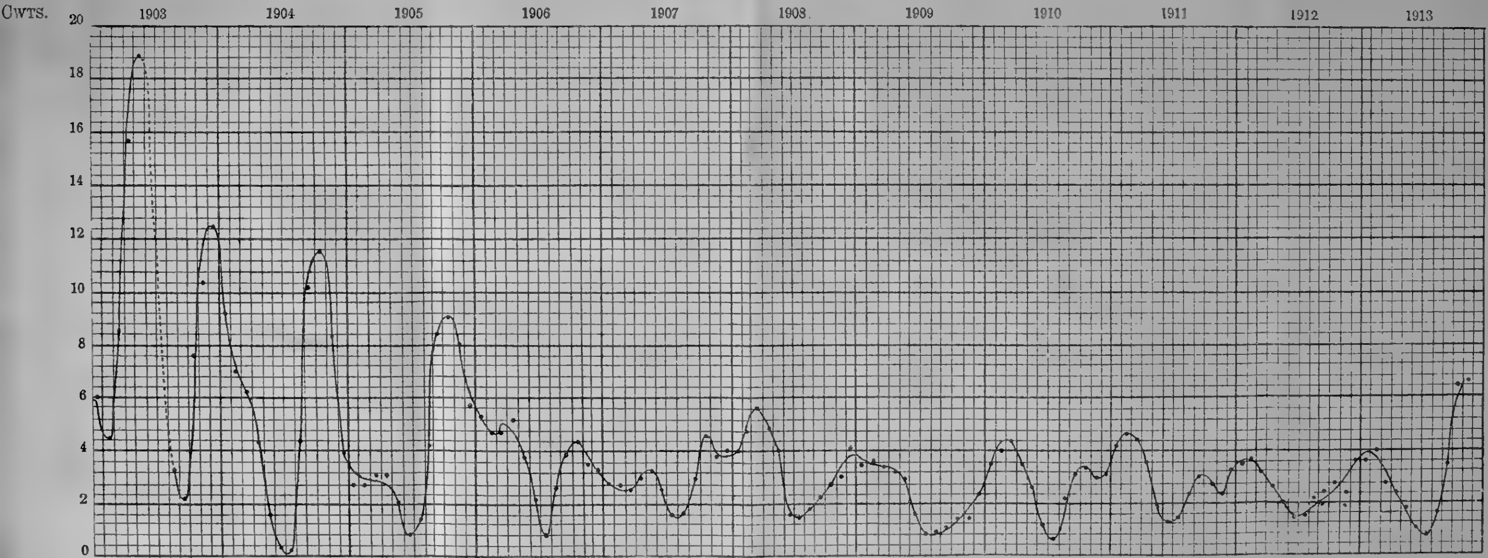
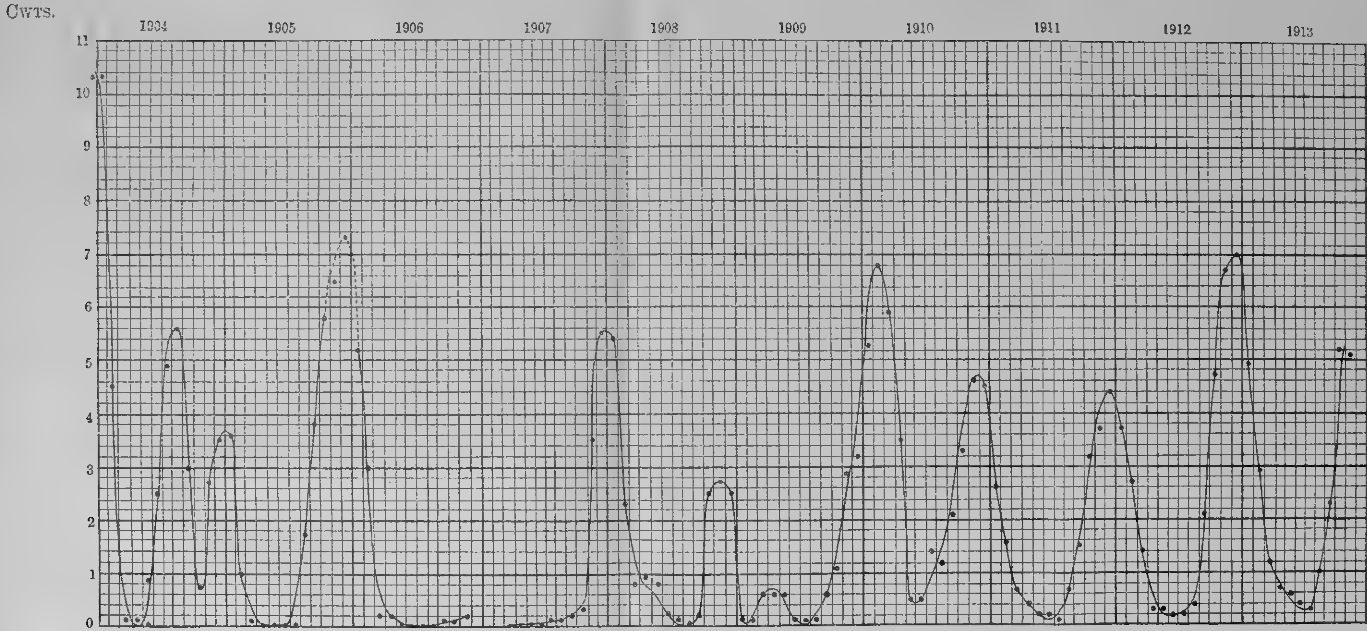


FIG. 11 MEAN MONTHLY CATCH OF LARGE MEGRIMS IN CWTS. PER 100 HOURS' TRAWLING IN AREA X. (SMOOTHED CURVE)

Wt 1505-14 500 10/14 M'F&L



Wt 1505-14 500 10/14 M'F & E

Fig. 12 Mean Monthly Catch of Small Megrims in Cwts. per 100 Hours' Trawling in Area XIII. (Smoothed Curve)

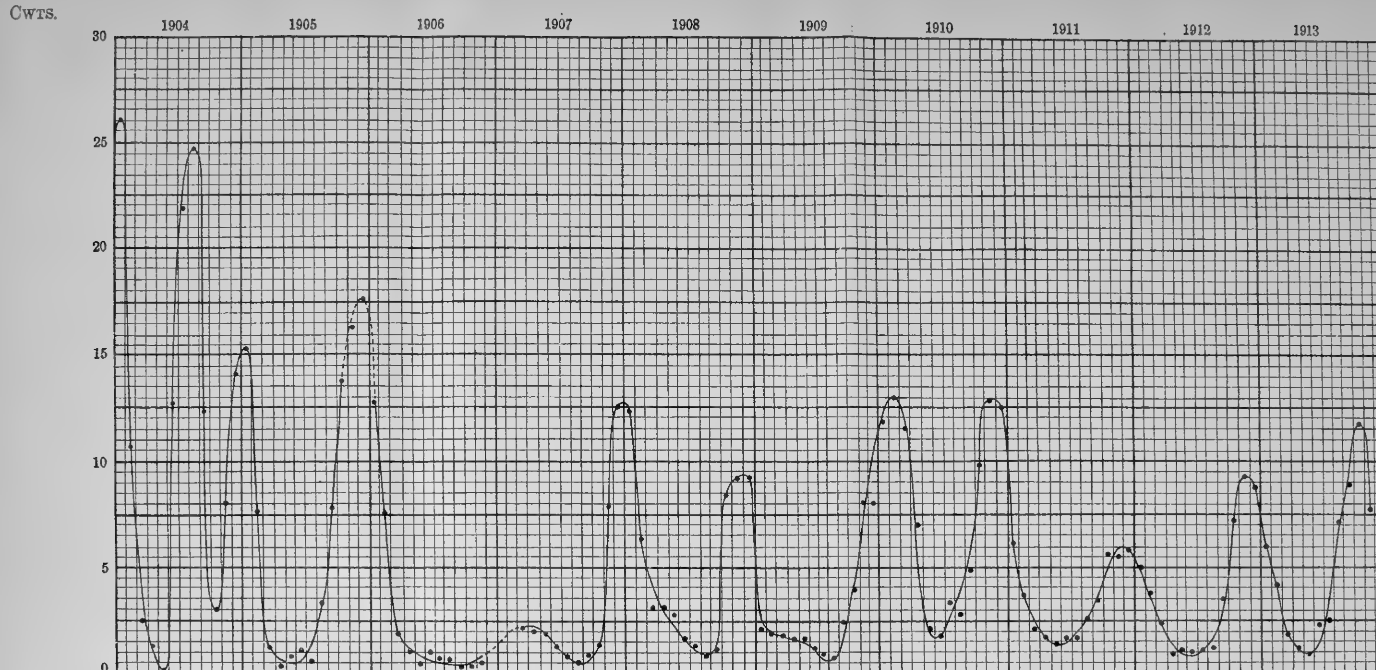


Fig. 13 Mean Monthly Catch of Large Megrims in Cwts. per 100 Hours' Trawling in Area XIII. (Smoothed Curve)

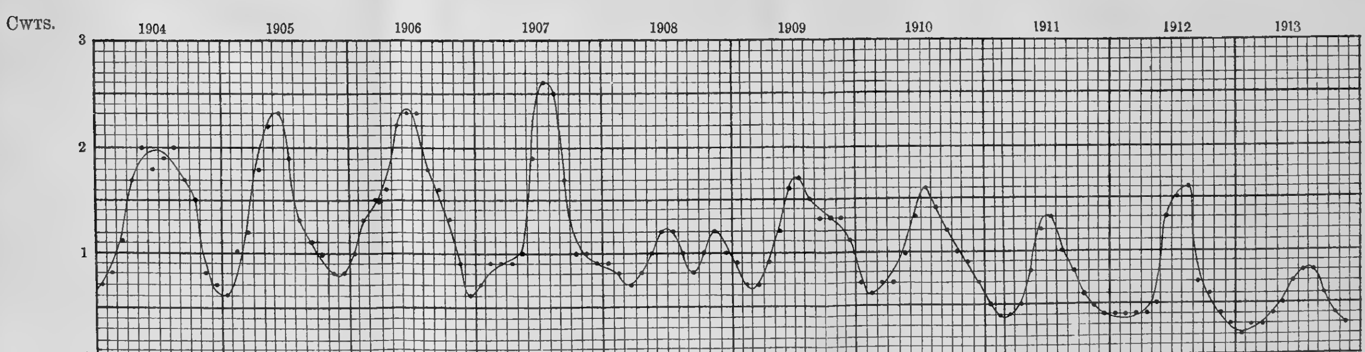


Fig. 14 Mean Monthly Catch of Large Lemons in Cwts. per 100 Hours' Trawling in Area X. (Smoothed Curve)

Wt 1505-14 500 10/14 M'F & E

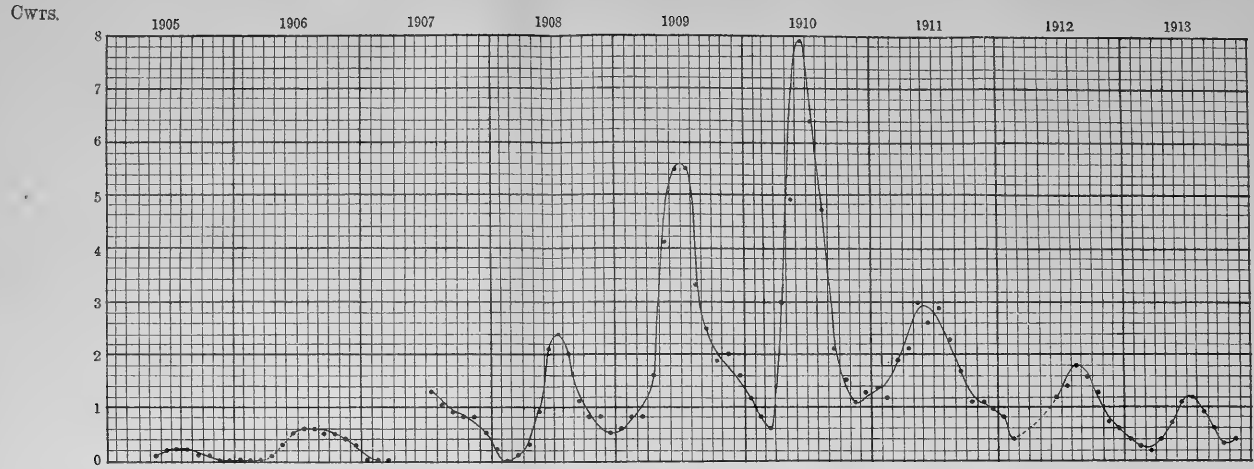
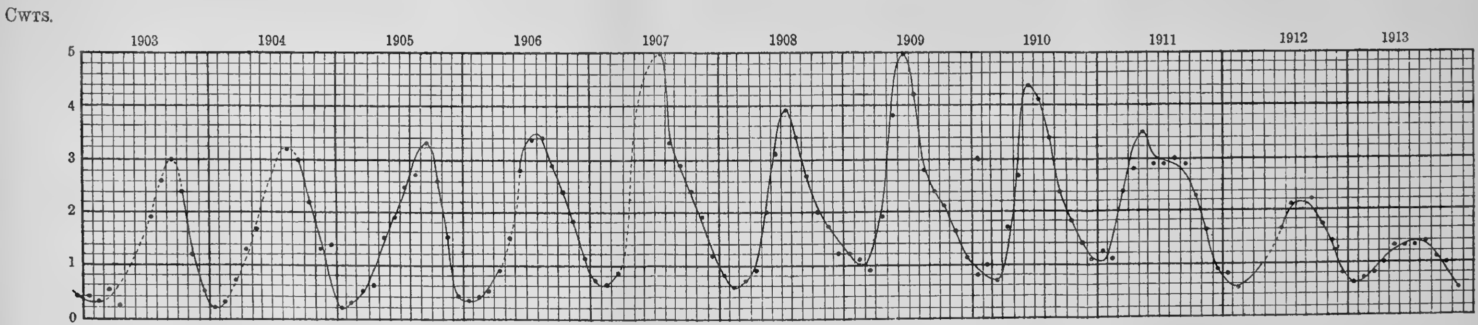


Fig. 15 Mean Monthly Catch of Small Lemons in Cwts. per 100 Hours' Trawling in Area XIV. (Smoothed Curve)



Wt 1505-14 500 10/14 M'F&E

Fig. 16 Mean Monthly Catch of Large Lemons in Cwts. per 100 Hours' Trawling in Area XIV. (Smoothed Curve)

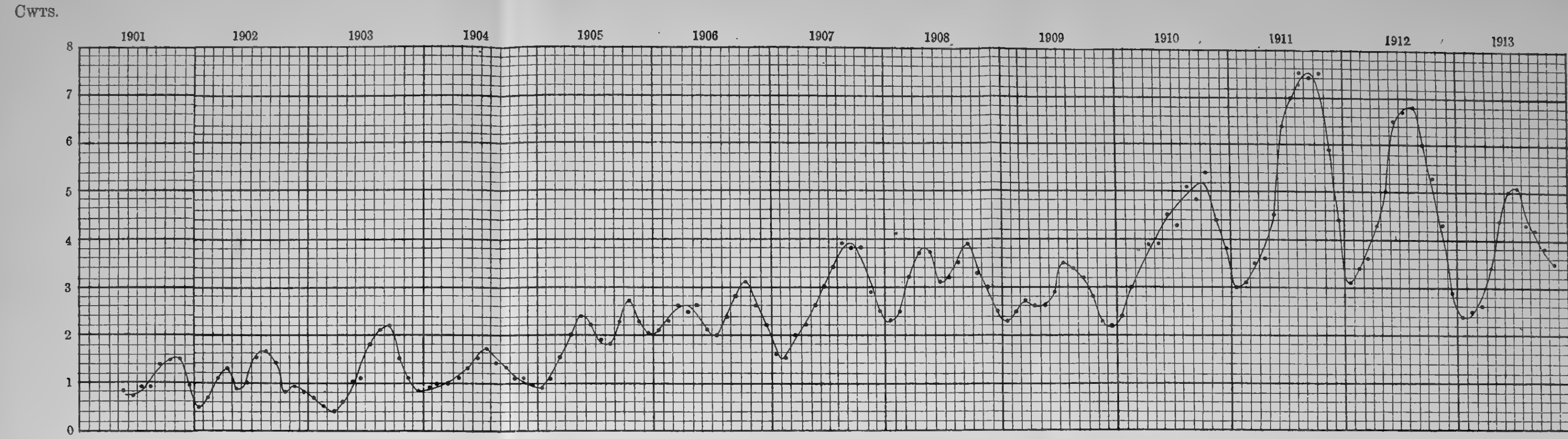


Fig. 17 Mean Monthly Catch of Small Lemons in Cwts. per 100 Hours' Trawling in Area XXIII. (Smoothed Curve)

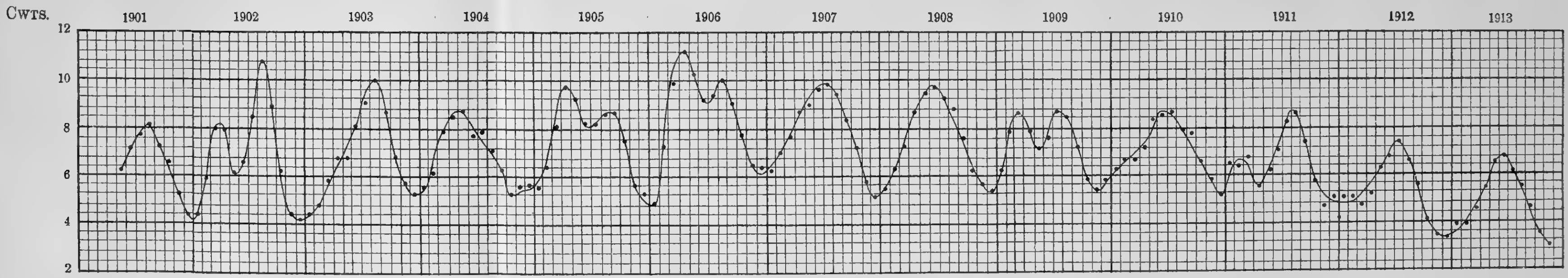


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Fig. 18 Mean Monthly Catch of Large Lemons in Cwts. per 100 Hours' Trawling in Area XXIII. (Smoothed Curve)

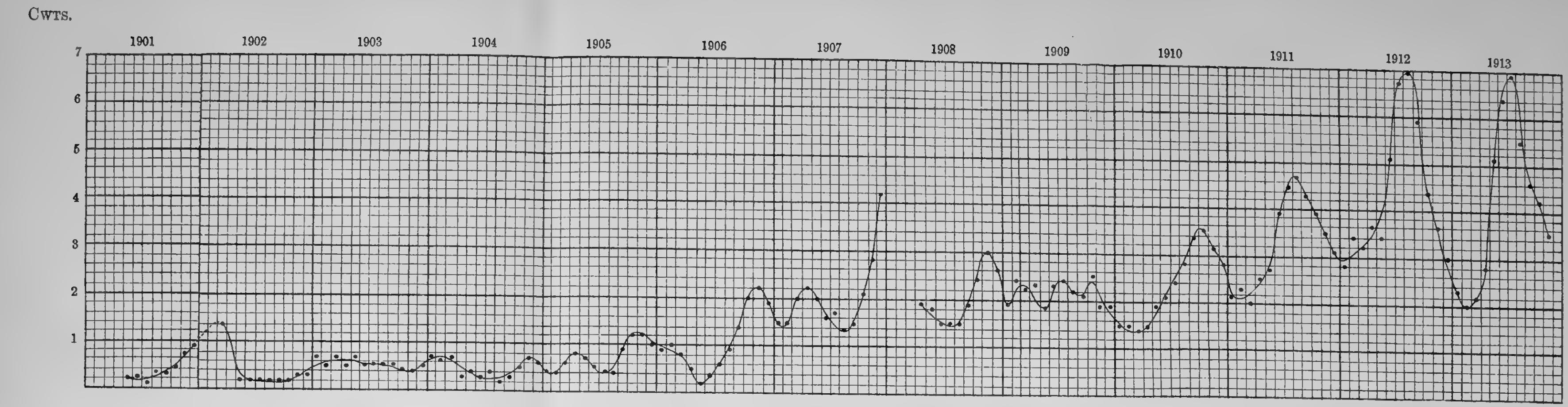

Fig. 19 Mean Monthly Catch of Small Lemons in Cwts. per 100 Hours' Trawling in Area XXIX. (Smoothed Curve)

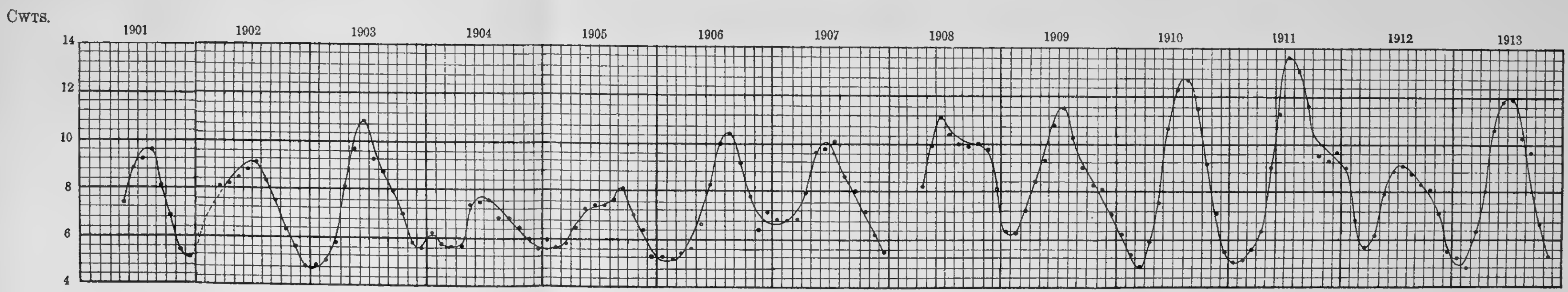

Fig. 20 Mean Monthly Catch of Large Lemons in Cwts. per 100 Hours' Trawling in Area XXIX. (Smoothed Curve)

Wt 1505-14 500 · 10/14 M'F & E

STATISTICAL TABLES.

I. *Epitomised Tables of the Catch landed at Aberdeen, in* 1913, *by British and Foreign Steam Trawlers.*

Note.—The figures here given are not identical with the official returns for the Port of Aberdeen, set forth in the Board's Annual Report for 1913, pp. 72, 73. The greater part of the Scottish landings by foreign vessels (pp. 122, 123) also refer to the Port of Aberdeen, and these foreign landings are here included. Secondly, as has been explained in our Fifth Report on North Sea Investigations (1913, p. 207) the method of estimating the weight of certain fish has, since 1909, been altered, in the direction of greater accuracy, in the Official Report; but here, for the sake of uniformity and comparison, the method in use in earlier years is still retained. It must be carefully understood that the weights given in these Tables are based on estimate and not on actual weighings. Strictly speaking, these statistics are based on a unit of *measurement*, viz. the so-called hundredweight box, and not upon a unit of *weight*.

In the total quantities dealt with, the discrepancy between these figures and those of the official returns amounts, after taking the foreign landings into account, to about 2·3 per cent. After further taking account of the differences of estimated weight, the discrepancy practically disappears.

A.—Total Catch in Cwts. of Trawled Fish landed at ABERDEEN during the Year 1913.

Area.	No. of Trips.	No. of Days.	Cod.	Codling.	Ling.	Tusk.	Saithe.	Hake.	Haddocks. E. Large.	Haddocks. Large.	Haddocks. Medium.	Haddocks. Small.	Haddocks. E. Small.	Whiting.	Turbot.	Halibut.	Brill.	Lemons. Large.	Lemons. Small.
Northern Grounds	1,850	13,089	56,905	61,890	39,452	1,188	89,243	8,536	3,187	43,126	20,883	33,038	6,552	36,084	215	3,331	14	775	440
East Coast Grounds	5,102	13,950	47,267	28,886	9,268	34	14,812	1,517	122	10,071	12,114	33,526	14,084	44,914	921	915	89	8,773	6,308
Middle Grounds	1,660	8,568	35,366	16,816	14,724	447	55,244	1,496	292	15,342	11,986	32,292	9,084	34,121	136	1,429	4	1,124	265
South-East Grounds	264	1,849	3,796	3,925	742	1	1,845	73	906	12,320	4,722	4,749	392	2,674	42	219	9	398	40
North Sea, Various	1,218	8,128	29,711	27,470	15,530	408	37,515	3,300	1,174	18,030	10,061	19,087	5,060	20,044	174	1,508	14	1,220	574
Total North Sea	10,094	45,584	173,045	138,987	79,718	2,078	198,658	14,922	5,681	98,891	59,767	122,692	35,172	137,837	1,488	7,402	131	12,290	7,626
Western Grounds	720	5,837	36,972	21,012	7,651	73	19,422	1,449	2,153	19,597	9,548	11,129	737	3,971	165	1,286	49	471	310
Faroe and Iceland	959	12,573	295,493	126,602	9,742	139	97,542	16	57,354	26,118	5,239	5,088	130	2,038	2	4,005	0	3,020	687
Mixed Grounds	274	2,425	10,070	11,239	2,839	72	6,884	897	874	5,315	2,432	3,556	452	2,145	42	500	12	396	210
Norway	12	123	169	1,653	220	1	1,764	–	323	1,130	156	122	–	195	1	41	–	3	0
White Sea	27	588	943	6,679	2	–	5	5	12,710	188	2	18	–	–	–	51	–	0	–
Grand Total	12,086	67,130	516,691	306,173	100,172	2,364	324,275	17,288	79,096	151,238	77,143	142,585	36,491	146,187	1,698	13,286	192	16,180	8,834

Area.	Plaice. Large.	Plaice. Medium.	Plaice. Small.	Dabs.	Witches. Large.	Witches. Small.	Megrims. Large.	Megrims. Small.	Eel.	Skate.	Gurnard.	Catfish.	Monk.	Squid.	Mackerel.	Herrings.	Other Kinds.	Grand Total. Cwts.	Gross Earnings. £
Northern Grounds	43	896	127	35	1,242	2,973	3,745	2,258	74	14,136	323	2,709	5,878	4	1,387	189	4,927	445,808	256,493
East Coast Grounds	207	5,027	2,118	1,459	1,351	2,047	1,451	222	152	16,036	2,210	6,010	5,836	6	138	992	678	279,563	204,604
Middle Grounds	36	424	14	152	3,477	8,829	2,112	737	22	5,711	318	1,268	5,026	12	865	2,133	266	261,572	170,335
South-East Grounds	116	643	96	7	126	25	9	2	1	476	8	170	131	–	573	5,749	113	45,102	38,675
North Sea, Various	72	1,001	193	54	1,002	2,217	1,695	1,021	60	7,956	404	1,566	3,311	13	620	1,567	1,863	215,500	132,298
Total North Sea	475	7,992	2,549	1,707	7,199	16,092	9,013	4,241	309	44,316	3,263	11,724	20,181	35	3,584	10,630	7,848	1,247,546	802,406
Western Grounds	152	2,197	1,057	124	142	290	463	237	273	8,940	262	315	818	–	376	457	424	152,522	96,648
Faroe and Iceland	262	1,737	144	130	1,626	105	434	14	2	2,127	9	8,208	702	6	2	20	8,899	657,645	253,548
Mixed Grounds	56	631	195	45	88	186	234	146	50	2,512	221	639	473	–	95	381	442	54,309	32,914
Norway	1	19	–	–	2	9	7	4	–	33	–	5	15	–	–	10	29	5,912	3,114
White Sea	12	452	71	–	–	–	31	–	–	1	–	223	–	–	–	7	203	21,606	8,665
Grand Total	958	13,029	4,015	2,007	9,059	16,681	10,181	4,642	635	57,929	3,756	21,113	22,190	41	4,057	11,505	17,845	2,139,540	1,197,295

B.—Average Catch in Cwts. per Trip. ABERDEEN TRAWLERS, 1913.

Area.	Cod.	Cod-ling.	Ling.	Tusk.	Saithe.	Hake.	Haddocks. E. Large.	Haddocks. Large.	Haddocks. Medium.	Haddocks. Small.	Haddocks. E. Small.	Whiting.	Turbot.	Halibut.	Brill.	Lemons. Large.	Lemons. Small.	Plaice. Large.	Plaice. Medium.	Plaice. Small.
Northern Grounds	30·76	33·45	21·32	·64	48·24	4·61	1·72	23·31	11·29	17·86	3·54	19·50	·12	1·80	·01	·42	·24	·02	·48	·07
East Coast Grounds	9·26	5·66	1·82	·01	2·90	·30	·02	1·97	2·37	6·57	2·76	8·80	·18	·18	·02	1·72	1·24	·04	·99	·41
Middle Grounds	21·30	10·13	8·87	·27	23·28	·90	·18	9·24	7·22	19·45	5·47	20·55	·08	·86	·00	·68	·16	·02	·26	·01
South-East Grounds	14·38	14·87	2·81	·01	6·99	·27	3·43	46·67	17·89	17·99	1·48	10·13	·16	·83	·03	1·51	·15	·44	2·44	·36
North Sea, Various	24·39	22·55	12·75	·34	30·80	2·71	·96	14·80	8·26	15·67	4·15	16·46	·14	1·24	·01	1·00	·47	·06	·82	·16
Total North Sea	17·14	13·77	7·90	·21	19·68	1·48	·56	9·80	5·92	12·16	3·48	13·66	·15	·73	·01	1·22	·76	·05	·79	·25
Western Grounds	51·35	29·19	10·63	·10	26·98	2·01	2·99	27·22	13·26	15·46	1·02	5·52	·23	1·79	·07	·65	·42	·21	3·05	1·47
Faroe and Iceland	308·20	132·05	10·16	·14	101·74	·02	59·82	27·24	5·46	5·31	·14	2·13	·00	4·18	·00	3·15	·72	·27	1·81	·15
Mixed Grounds	36·76	41·02	10·36	·26	25·13	3·27	3·19	19·40	8·88	12·91	1·65	7·83	·15	1·82	·04	1·44	·77	·20	2·30	·71
Norway	14·05	137·79	18·36	·07	146·99	0·00	26·91	94·15	12·99	10·15	·00	16·23	·07	3·46	·00	·23	·02	·10	1·57	·00
White Sea	34·91	247·39	·06	·00	·20	·18	470·79	6·97	·07	·67	·00	·00	·00	1·88	·00	·00	·00	·45	16·76	2·63
Grand Total	42·75	25·33	8·29	·20	26·83	1·43	6·54	12·51	6·38	11·80	3·02	12·10	·14	1·10	·02	1·34	·73	·08	1·08	·33

Area.	Dabs.	Witches. Large.	Witches. Small.	Megrims. Large.	Megrims. Small.	Eel.	Skate.	Gurnard.	Cat-fish.	Monk.	Squid.	Mackerel.	Herrings.	Other Kinds.	Grand Total. Cwts.	Gross Earnings. £	Value per Cwt. in Shillings.
Northern Grounds	·02	·67	1·61	2·02	1·22	·04	7·64	·17	1·46	3·18	·00	·75	·10	2·66	240·96	138·63	11·51
East Coast Grounds	·28	·26	·40	·28	·04	·03	3·14	·43	1·18	1·14	·00	·03	·19	·13	54·79	40·10	14·64
Middle Grounds	·09	2·09	5·32	1·27	·44	·01	3·44	·19	·76	3·03	·01	·52	1·28	·16	157·57	102·61	13·02
South-East Grounds	·03	·48	·10	·03	·01	·00	1·80	·03	·65	·50	·00	2·17	21·78	·43	170·85	146·50	17·15
North Sea, Various	·04	·82	1·82	1·39	·84	·05	6·53	·33	1·29	2·72	·01	·51	1·29	1·53	176·92	108·62	12·28
Total North Sea	·17	·71	1·59	·89	·42	·03	4·39	·32	1·16	2·00	·00	·36	1·05	·78	123·59	79·49	12·86
Western Grounds	·17	·20	·40	·64	·33	·38	12·42	·36	·44	1·14	·00	·52	·63	·59	211·85	134·24	12·67
Faroe and Iceland	·13	1·70	·11	·45	·01	·00	2·22	·01	8·56	·73	·01	·00	·02	9·28	685·92	264·45	7·71
Mixed Grounds	·17	·32	·68	·85	·53	·18	9·17	·81	2·33	1·73	·00	·35	1·39	1·61	198·23	120·14	12·12
Norway	·00	·20	·75	·56	·31	·00	2·79	·00	·40	1·25	·00	·00	·83	2·42	492·66	259·51	10·53
White Sea	·00	·07	·00	1·14	·00	·00	·04	·00	8·28	·00	00	·00	·26	7·53	800·27	320·94	8·02
Grand Total	·17	·75	1·38	·84	·38	·05	4·79	·31	1·75	1·84	·00	·34	·95	1·48	177·03	99·06	11·19

C.—Percentage of Total Catch yielded by the Different Areas, 1913. ABERDEEN TRAWLERS.

Area.	No. of Trips.	Cod.	Cod-ling.	Total.	Ling.	Tusk.	Saithe.	Hake.	HADDOCKS.						Whit-ing.	Tur-bot.	Hali-but.	Brill.	LEMONS.		
									E. Large.	Large.	Med-ium.	Small.	E. Small.	Total.					Large.	Small.	Total.
Northern Grounds	15·3	11·0	20·2	14·4	39·4	50·2	27·5	49·4	4·0	28·5	27·1	23·2	17·9	21·9	24·7	12·7	25·1	7·4	4·8	5·0	4·9
East Coast Grounds	42·2	9·1	9·4	9·3	9·3	1·4	4·6	8·8	0·2	6·7	15·7	23·5	38·6	14·4	30·7	54·2	6·9	46·3	54·2	71·4	60·3
Middle Grounds	13·7	6·8	5·5	6·3	14·7	18·9	17·0	8·6	0·4	10·1	15·5	22·6	24·9	14·2	23·3	8·0	10·8	2·3	6·9	3·0	5·5
South-East Grounds	2·2	0·7	1·3	0·9	0·7	0·1	0·6	0·4	1·1	8·1	6·1	3·3	1·1	4·7	1·8	2·5	1·6	4·7	2·5	0·4	1·8
North Sea, Various	10·1	5·7	9·0	6·9	15·5	17·3	11·6	19·1	1·5	11·9	13·0	13·4	13·9	11·0	13·7	10·2	11·3	7·4	7·5	6·5	7·2
Total North Sea	83·5	33·5	45·4	37·9	79·6	87·9	61·3	86·3	7·2	65·4	77·4	86·0	96·4	66·2	94·3	87·6	55·7	68·1	76·0	86·3	79·6
Western Grounds	6·0	7·2	6·9	7·0	7·6	3·1	6·0	8·4	2·7	13·0	12·4	7·8	2·0	8·9	2·7	9·7	9·7	25·3	2·9	3·5	3·1
Faroe and Iceland	7·9	57·2	41·3	51·3	9·7	5·9	30·1	0·1	72·5	17·3	6·8	3·6	0·4	19·3	1·4	0·1	30·1	0·2	18·7	7·8	14·8
Mixed Grounds	2·3	1·9	3·7	2·6	2·8	3·0	2·1	5·2	1·1	3·5	3·2	2·5	1·2	2·6	1·5	2·5	3·8	6·3	2·4	2·4	2·4
Norway	·1	0·0	0·5	0·2	0·2	0·0	0·5	0·0	0·4	0·7	0·2	0·1	0·0	0·4	0·1	0·1	0·3	0·0	0·0	0·0	0·0
White Sea	·2	0·2	2·2	0·9	0·0	0·0	0·0	0·0	16·1	[illegible]	0·0	0·0	0·0	2·6	0·0	0·0	0·4	0·0	0·0	0·0	0·0

Area.	PLAICE.				Dabs.	WITCHES.			MEGRIMS.			Eel.	Skate.	Gur-nard.	Cat-fish.	Monk.	Squid.	Mack-erel.	Her-rings.	Other Kinds.	Grand Total. Cwts.	Gross Earnings. £
	Large.	Med-ium.	Small.	Total.		Large.	Small.	Total.	Large.	Small.	Total.											
Northern Grounds	4·5	6·9	3·2	5·9	1·7	13·7	17·8	16·4	36·8	48·6	40·5	11·6	24·4	8·6	12·8	26·5	9·5	34·2	1·6	27·6	20·8	21·4
East Coast Grounds	21·6	38·6	52·8	40·8	72·7	14·9	12·3	13·2	14·3	4·8	11·3	23·9	27·7	58·8	28·5	26·3	15·1	3·4	8·6	3·8	13·1	17·1
Middle Grounds	3·8	3·3	0·4	2·6	7·6	38·4	52·9	47·8	20·7	15·9	19·2	3·5	9·9	8·5	6·0	22·7	28·8	21·3	18·5	1·5	12·2	14·2
South-East Grounds	12·1	4·9	2·4	4·8	0·4	1·4	0·2	0·6	0·1	0·0	0·1	0·2	0·8	0·2	0·8	0·6	0·0	14·1	49·9	0·6	2·1	3·2
North Sea, Various	7·5	7·7	4·8	7·0	2·7	11·1	13·3	12·5	16·6	22·0	18·3	9·5	13·7	10·8	7·4	14·9	32·0	15·3	13·6	10·4	10·1	11·1
Total North Sea	49·6	61·3	63·5	61·2	85·1	79·5	96·5	90·5	88·5	91·3	89·4	48·7	76·5	86·9	55·5	91·0	85·4	88·3	92·4	44·0	58·3	67·0
Western Grounds	15·9	16·9	26·3	18·9	6·2	1·6	1·7	1·7	4·5	5·1	4·7	43·1	15·4	7·0	1·5	3·7	0·0	9·3	4·0	2·4	7·1	8·1
Faroe and Iceland	27·3	13·3	3·6	11·9	6·5	17·9	0·6	6·7	4·3	0·3	3·0	0·4	3·7	0·2	38·9	3·2	14·6	0·1	0·2	49·9	30·7	21·2
Mixed Grounds	5·8	4·8	4·8	4·9	2·3	1·0	1·1	1·1	2·3	3·2	2·6	7·8	4·3	5·9	3·0	2·1	0·0	2·3	3·3	2·5	2·5	2·7
Norway	0·1	0·1	0·0	0·1	0·0	0·0	0·1	0·0	0·1	0·1	0·1	0·0	0·1	0·0	0·0	0·1	0·0	0·0	0·1	0·2	0·3	0·3
White Sea	1·3	3·5	1·8	3·0	0·0	0·0	0·0	0·0	0·3	0·0	0·2	0·0	0·0	0·0	1·1	0·0	0·0	0·0	0·1	1·1	1·0	0·7

D.—Average Catch in Cwts. per Day's Absence from Port. ABERDEEN TRAWLERS, 1913.

Area.	No. of Days.	Average Days per Trip.	Cod.	Codling.	Ling.	Tusk.	Saithe.	Hake.	Haddocks. E. Large.	Haddocks. Large.	Haddocks. Medium.	Haddocks. Small.	Haddocks. E. Small.	Whiting.	Turbot.	Halibut.	Brill.	Lemons. Large.	Lemons. Small.
Northern Grounds	13,089	7·1	4·3	4·7	3·0	0·1	6·8	·7	·2	3·3	1·6	2·5	·5	2·8	·0	·2	·0	·1	·0
East Coast Grounds	13,950	2·7	3·4	2·1	·7	·0	1·1	·1	·0	·7	·9	2·4	1·0	3·2	·1	·1	·0	·6	·5
Middle Grounds	8,568	5·2	4·1	2·0	1·7	·1	6·4	·2	·0	1·8	1·4	3·8	1·1	4·0	·0	·2	·0	·1	·0
South-East Grounds	1,849	7·0	2·1	2·1	·4	·0	1·0	·0	·5	6·7	2·5	2·6	·2	1·4	·0	·1	·0	·2	·0
North Sea, Various	8,128	6·7	3·7	3·4	1·9	·1	4·6	·4	·1	2·2	1·2	2·3	·6	2·5	·0	·2	·0	·1	·1
Total North Sea	45,584	4·5	3·8	3·0	1·7	·0	4·4	·3	·1	2·2	1·3	2·7	·8	3·0	·0	·2	·0	·3	·2
Western Grounds	5,837	8·1	6·3	3·6	1·3	·0	3·3	·2	·4	3·4	1·6	1·9	·1	·7	·0	·2	·0	·1	·1
Faroe and Iceland	12,573	13·1	23·5	10·1	·8	·0	7·8	·0	4·6	2·1	·4	·4	·0	·2	·0	·3	·0	·2	·1
Mixed Grounds	2,425	8·9	4·1	4·6	1·2	·0	2·8	·1	·4	2·2	1·0	1·5	·2	·9	·0	·2	·0	·2	·1
Norway	123	10·3	1·4	13·4	1·8	·0	14·3	·0	2·6	9·2	1·3	1·0	·0	1·6	·0	·3	·0	·0	·0
White Sea	588	21·8	1·6	11·4	·0	·0	·0	·0	21·6	·3	·0	·0	·0	·0	·0	·1	·0	·0	·0
Grand Total	67,130	5·6	7·7	4·6	1·5	·0	1·8	·3	1·2	2·2	1·1	2·1	·5	2·2	·0	·2	·0	·2	·1

Area.	Plaice. Large.	Plaice. Medium.	Plaice. Small.	Dabs.	Witches. Large.	Witches. Small.	Megrims. Large.	Megrims. Small.	Eel.	Skate.	Gurnard.	Catfish.	Monk.	Squid.	Mackerel.	Herrings.	Other Kinds.	Grand Total. Cwts.	Gross Earnings. £
Northern Grounds	·0	·1	·0	·0	·1	·2	·2	·2	·0	1·1	·0	·2	·4	·0	·1	·0	·4	34·1	19·6
East Coast Grounds	·0	·4	·1	·1	·1	·1	·1	·0	·0	1·1	·2	·1	·4	·0	·0	·1	·0	20·0	14·7
Middle Grounds	·0	·0	·0	0	·4	1·0	·2	·1	·0	·7	·0	·1	·6	·0	·1	·2	·0	30·5	19·9
South-East Grounds	·1	·3	·1	·0	·1	·0	·0	·0	·0	·3	·0	·1	·1	·0	·3	3·1	·1	24·4	20·9
North Sea, Various	·0	·1	·0	·0	·1	·3	·2	·1	·0	1·0	·0	·2	·4	·0	·1	·2	·2	26·5	16·3
Total North Sea	·0	·2	·1	·0	·2	·3	·2	·1	·0	1·0	·1	·3	·4	·0	·1	·2	·2	27·4	17·6
Western Grounds	·0	·4	·2	·0	·0	·0	·1	·0	·0	1·5	·0	·1	·1	·0	·1	·1	·1	26·1	16·6
Faroe and Iceland	·0	·1	·0	·0	·1	·0	·0	·0	·0	·2	·9	·6	·1	·0	·0	·0	·7	52·3	20·2
Mixed Grounds	·0	·3	·1	·0	·0	·1	·1	·1	·0	1·0	·1	·3	·2	·0	·0	·2	·2	22·4	13·6
Norway	·0	·2	·0	·0	·0	·1	·1	·0	·0	·3	·0	·0	·1	·0	·0	·1	·2	48·1	25·3
White Sea	·0	·8	·1	·0	·0	·0	·1	·0	·0	·0	·0	·1	·0	·0	·0	·0	·3	36·7	14·7
Grand Total	·0	·2	·1	·0	·1	·2	·1	·1	·0	·9	·1	·3	·3	·0	·1	·2	·3	31·9	17·8

II. Returns of Place of Fishing, and of Fish landed by Steam Trawlers at Aberdeen Market, in 1913. *Based on returns from* 8648 *trawling voyages.*

NUMBER OF **Voyages** OF ABERDEEN TRAWLERS furnishing Detailed Returns of Place of Fishing and Hours of Trawling—1913 (excluding voyages during which the vessel fished on more areas than one).

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Av. No. of days spent on voyage.
VI.	6	4	4	40	5	–	–	–	–	7	20	–	86	7·8
VII.	–	–	–	2	1	–	–	–	–	–	1	–	4	7·3
VIII.	–	–	–	1	2	–	4	2	–	–	–	–	9	7·1
IX.	–	–	–	1	2	4	7	5	1	1	–	–	21	6·6
X.	12	27	28	81	88	46	55	22	8	23	35	22	447	7·6
XI.	3	6	26	10	13	2	6	4	–	–	1	1	72	7·1
XII.	–	3	13	11	1	1	2	11	1	–	–	–	43	7·3
XIII.	12	8	35	4	27	9	6	4	2	26	17	24	174	6·5
XIV.	32	81	10	1	21	21	20	11	23	42	26	45	333	6·4
XV.	40	78	38	4	5	1	–	1	1	6	4	13	191	6·9
XVI.	5	3	16	7	–	–	–	–	–	–	2	5	38	7·2
XVII.	34	49	86	69	39	45	52	15	10	22	20	62	503	4·6
XVIII.	38	51	68	17	8	22	103	132	91	113	46	43	732	4·1
XIX.	120	25	5	7	4	22	5	3	7	4	25	150	377	6·5
XX.	3	7	2	6	–	–	–	–	3	–	12	40	73	7·2
XXII.	2	7	–	–	–	–	–	–	–	–	–	1	10	4·4
XXIII.	205	189	120	116	298	258	310	352	312	299	265	277	3001	2·5
XXIV.	1	–	2	8	–	1	7	5	7	8	16	4	59	4·9
XXV.	–	1	–	–	2	–	1	1	11	7	11	2	36	7·1
XXVI.	–	–	1	–	–	–	–	12	20	5	4	2	44	7·5
XXVII.	–	–	–	–	–	–	2	3	2	–	–	–	7	7·0
XXVIII.	2	5	13	–	3	4	6	33	27	27	22	18	160	2·3
XXIX.	6	50	91	98	12	74	76	54	48	30	35	39	613	2·1
XXX.	–	1	–	–	–	1	–	2	2	12	14	–	32	5·6
XXI.	–	–	–	–	–	–	4	4	16	38	11	–	73	6·5
XXXII.	–	–	–	–	–	–	3	16	20	–	7	1	47	7·2
XXXIII.	–	–	–	–	–	–	–	2	–	–	–	–	2	8·5
XXXIV.	–	–	–	–	–	–	–	–	–	–	–	1	1	4·0
XXXV.	–	–	–	–	–	–	–	2	6	6	2	–	16	6·1
XXXVI.	–	–	–	–	–	–	–	–	1	1	–	–	1	6·0
XL.	–	–	–	–	–	–	–	–	2	–	–	–	2	6·0
XLIII.	–	–	–	–	–	–	–	–	1	–	–	–	1	7·0
C.	4	9	7	20	50	69	11	6	5	6	14	5	206	7·0
D.	11	10	8	8	–	5	1	–	3	2	3	9	60	9·7
J.	1	3	2	–	2	3	–	2	–	–	1	1	15	7·8
K.	3	4	4	3	2	–	2	1	–	–	–	1	20	9·5
L.	–	–	–	–	–	–	1	–	–	–	–	–	1	4·0
M.	–	1	–	–	2	–	–	4	2	–	–	–	9	8·3
S.	–	–	–	–	–	1	–	–	–	–	1	–	2	8·0
Minch	2	–	2	4	–	–	1	–	–	–	–	–	9	11·4
C.D. Minch	19	11	32	15	31	23	15	8	4	14	16	16	204	8·0
Rockall	–	–	–	–	–	1	–	–	–	–	–	–	1	10·0
Western Grounds	2	7	6	4	11	9	7	3	3	1	3	2	58	9·0
Faroe	24	21	49	66	16	19	58	19	41	13	6	9	341	10·7
Iceland	6	33	49	90	88	48	32	32	24	20	18	39	479	15·0
Norway	–	–	–	3	5	–	–	–	–	–	1	–	9	10·0
White Sea	–	–	–	–	–	–	–	3	13	6	–	3	25	21·7
Total	593	694	717	696	738	689	797	774	717	739	659	835	8648	5·3

NUMBER OF **Hours** OF ACTUAL TRAWLING BY ABERDEEN TRAWLERS, on which are based the Tables of Average Catch per 100 hours—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Av. No. of hours per trip.
VI.	459	262	234	3.323	544	–	–	–	–	654	1,708	–	7,184	83·5
VII.	–	–	–	162	100	–	–	–	–	–	94	–	356	89·0
VIII.	–	–	–	160	170	–	328	119	–	–	–	–	777	86·3
IX.	–	–	–	21	182	243	633	393	63	60	–	–	1,595	75·9
X.	716	1,711	1,671	6,096	6,695	3,109	3,802	1,551	622	1,870	3,114	1,854	32,811	73·4
XI.	164	520	2,204	704	1,027	162	517	343	–	–	86	45	5,772	80·2
XII.	–	308	1,114	991	84	48	201	1,117	52	–	–	–	3,915	91·0
XIII.	671	464	2,008	321	1,778	567	60	268	160	2,111	1,113	1,486	11,007	63·3
XIV.	1,899	6.235	475	84	1,471	1,448	1,185	758	1,572	3,891	2,042	3,297	24,357	73·1
XV.	3,184	7,343	3,034	324	397	92	–	120	72	557	332	1,096	16,551	86·7
XVI.	457	302	1,397	594	–	–	–	–	–	–	156	379	3,285	86·4
XVII.	1,310	1,927	4,048	3,482	2,055	2,377	2,514	879	504	1,043	1,085	2,923	24,147	48·0
XVIII.	1,947	2,633	2,815	981	392	1,428	6,945	8,600	6,127	7,235	3,024	3,137	45,264	61·8
XIX.	8,612	1,887	318	565	460	1,945	444	212	509	448	2,284	14,045	31,729	84·2
XX.	241	643	217	562	–	–	–	–	251	–	1,175	3,687	6,776	92·8
XXII.	69	243	–	–	–	–	–	–	–	–	–	63	375	37·5
XXIII.	4,706	5,522	2,909	3,713	9,700	8,796	11,784	14,140	13,321	9,322	8,293	8,414	100,620	33·5
XXIV.	12	–	92	466	–	52	401	416	454	578	1,333	231	4,035	68·4
XXV.	–	63	–	–	162	–	36	70	964	746	1,116	110	3,267	90·8
XXVI.	–	–	76	–	–	–	–	1,152	2,190	484	475	130	4,507	102·4
XXVII.	–	–	–	–	–	–	91	291	133	–	–	–	515	73·6
XXVIII.	56	145	218	–	89	129	249	1,056	988	792	531	453	4,706	29·4
XXIX.	110	1,871	1,790	3,165	377	2,581	2,602	1,846	1,780	830	820	1,179	18,951	30·9
XXX.	–	60	–	–	–	44	–	176	188	1,019	1,094	–	2,581	80·7
XXXI.	–	–	–	–	–	–	330	320	1,401	3,609	968	–	6,628	90·8
XXXII.	–	–	–	–	–	–	300	1,552	1,936	–	575	64	4,427	94·2
XXXIII.	–	–	–	–	–	–	–	140	–	–	–	–	140	70·0
XXXIV.	–	–	–	–	–	–	–	–	–	–	–	21	21	21·0
XXXV.	–	–	–	–	–	–	–	80	393	607	128	–	1,208	75·5
XXXVI.	–	–	–	–	–	–	–	–	94	90	–	–	184	92·0
XL.	–	–	–	–	–	–	–	–	120	–	–	–	120	60·0
XLIII.	–	–	–	–	–	–	–	–	30	–	–	–	30	30·0
C.	279	535	419	1,397	3,232	4280	706	469	265	345	965	156	13,048	63·3
D.	541	476	391	565	–	350	140	–	113	120	251	369	3,316	55·3
J.	18	226	95	–	57	182	–	165	–	–	12	36	791	52·7
K.	123	180	279	243	168	–	225	96	–	–	–	12	1,326	66·3
L.	–	–	–	–	–	–	54	–	–	–	–	–	54	54·0
M.	–	63	–	–	150	–	–	217	84	–	–	–	514	57·1
S.	–	–	–	–	–	60	–	–	–	–	90	–	150	75·0
Minch	132	–	150	266	–	–	48	–	–	–	–	–	596	66·2
C.D. Minch	992	641	1.630	824	1,844	1,223	958	548	257	1,060	1,049	860	11,886	58·3
Rockall	–	–	–	–	–	78	–	–	–	–	–	–	78	78·0
Western Grounds	170	408	302	289	656	605	442	226	294	84	140	115	3,731	64·3
Faroe	1,603	1,604	3,519	4,393	1,190	1,647	4,824	1,436	3,293	1,183	447	776	25,927	76·0
Iceland	372	2,427	3,978	8,192	8,369	5,382	5,151	4,697	3,786	3,452	3,042	4,317	53,165	111·0
Norway	–	–	–	112	195	–	–	–	–	–	48	–	355	39·4
White Sea	–	–	–	–	–	–	–	268	1,936	1,074	–	96	3,374	135·0
Total	28,846	38,699	35,383	41,995	41,553	36,828	44,970	43,721	34,952	43,264	37,590	49,351	486,152	56·2

AVERAGE CATCH OF **Cod**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	52·0	28·0	14·1	14·0	16·0	–	–	–	–	15·8	19·6	–
IX.	–	–	–	90·5*	45·6	160·4	74·1	32·9	31·7*	29·7*	–	–
X.	55·2	47·7	35·6	49·2	54·7	115·6	130·5	56·3	19·9	15·7	14·7	20·2
XI.	49·6	19·8	15·4	10·1	8·8	8·5	14·6	15·7	–	–	20·7*	25·6*
XII.	–	12·8	16·5	7·8	17·6*	5·2*	11·9	9·3	13·5*	–	–	–
XIII.	64·9	104·7	79·2	36·7	104·2	51·7	667·6*	7·6	55·2	41·0	53·9	56·4
XIV.	50·6	27·4	37·5	19·4*	84·5	60·0	91·7	44·7	43·9	43·9	44·6	35·5
XV.	17·1	18·7	15·9	11·6	20·7	53·0*	–	23·3	84·0*	35·8	33·7	36·8
XVI.	14·7	14·1	17·8	8·2	–	–	–	–	–	–	9·6	14·5
XVII.	137·4	37·4	179·4	98·9	31·9	42·5	26·5	23·6	11·6	7·3	15·9	24·2
XVIII.	25·1	29·6	64·5	41·9	15·3	39·1	50·1	47·6	40·1	38·9	36·1	28·8
XIX.	16·6	20·3	10·3	8·2	20·8	29·3	52·2	41·9	36·0	20·3	28·1	23·3
XX.	11·1	13·7	12·0	11·0	–	–	–	–	10·9	–	15·5	12·5
XXIII.	31·4	26·5	20·9	26·9	23·3	19·5	28·9	18·9	22·7	9·3	8·6	10·4
XXIV.	4·2*	–	27·7	17·3	–	8·3*	18·8	27·3	37·3	41·1	18·1	16·8
XXV.	–	14·0*	–	–	9·9	–	·3*	3·6*	22·2	16·3	17·8	11·8
XXVI.	–	–	16·4*	–	–	–	–	8·0	8·3	11·6	9·3	12·9
XXVIII.	36·3*	14·5	6·4	–	8·8*	4·5	4·2	2·7	1·0	2·5	4·1	8·2
XXIX.	9·4	12·6	54·1	39·7	7·7	4·4	5·1	3·9	2·7	5·7	2·9	8·2
XXX.	–	5·8*	–	–	–	8·6*	–	17·3	33·0	27·8	27·3	–
XXXI.	–	–	–	–	–	–	19·1	15·8	26·7	18·5	12·1	–
XXXII.	–	–	–	–	–	–	8·7	5·6	8·2	–	5·6	17·2*
C.	82·1	56·0	94·8	191·1	47·4	93·8	54·8	14·3	28·6	40·1	50·8	151·3
D.	169·3	59·1	261·3	166·1	–	67·7	68·1	–	14·6	14·6	23·9	105·8
J.	·6*	144·5	16·6*	–	39·5*	145·2	–	50·5	–	–	56·7*	52·8*
K.	173·4	227·2	621·0	509·8	115·6	–	13·8	16·7*	–	–	–	16 7*
Var. N Sea	37·2	30·2	39·3	41·7	52·0	52·8	45·1	32·7	19·3	24·8	20·0	24·1
C.D. Minch	110·2	94·3	118·4	82·4	59·1	78·1	63·3	16·8	11·2	23·7	29·4	57·4
Western Grounds	70·9	80·5	162·8	152·2	56·2	98·2	44·9	27·4	26·5	20·2*	22·4	77·2
Faroe	20·9	43·5	98·0	208·5	28·1	16·7	12·6	19·0	18·4	17·7	11·7	10·2
Iceland	862·5	1151·2	878·9	819·7	629·1	269·8	149·1	95·5	66·2	90·2	118·9	222·7

Area VII., Apr. 5·1, May 8·5*, Nov. 19·7*; VIII., Apr. 8·6, May 4·3, July 19·6, Aug. 7·8; XXII., Jan. 14·5*, Feb. 13·2, Dec. 8·7*; XXVII., July 6·6*, Aug. 5·2, Sept. 19·5; XXXIII., Aug. 18·1; XXXIV., Dec. 8·6*; XXXV., Aug. 106·6*, Sept. 62·5, Oct. 29·3, Nov. 76·6; XXXVI., Sept. 17·0*, Oct. 7·5*; XL., Sept. 15·8; XLIII., Sept. 1·0*; M., Feb. 13·5*, May 29·2, Aug. 6·0, Sept. 7·3*; L., July 82·4*; S., June 117·2*, Nov. 77·8*; Minch, Jan. 43·3, Mar. 83·9, Apr. 83·9, July 40·6*; Rockall, June 235·9*; Norway, Apr. 49·4, May 24·6, Nov. 1·0*; White Sea, Aug. 242·7, Sept. 6·1, Oct. 4·7, Dec. 118·6*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Codling**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	47·3	29·4	21·5	22·9	23·5	–	–	–	–	28·8	31·1	
IX.	–	–	–	104·8*	86·0	95·0	73·5	77·7	28·6*	52·5*	–	–
X.	46·3	54·0	43·6	47·3	55·8	92·1	132·2	69·1	29·1	23·8	23·0	23·8
XI.	46·8	23·5	17·4	14·2	17·6	18·1	32·5	35·4	–	–	16·0*	48·4*
XII.	–	15·7	15·6	16·5	11·3*	20·4*	14·4	14·4	8·3*	–	–	–
XIII.	89·0	49·5	49·5	10·8	81·9	114·3	636·5	42·8	35·2	21·5	23·9	64·0
XIV.	86·6	48·5	48·9	11·9*	97·0	89·9	88·6	76·2	45·0	26·1	26·0	67·1
XV.	27·8	19·7	15·1	22·2	13·9	19·6*	–	12·9	76·4*	18·9	19·0	22·1
XVI.	15·5	14·2	13·2	15·6	–	–	–	–	–	–	15·1	13·0
XVII.	19·5	21·6	26·0	21·9	14·7	23·6	24·6	44·5	20·4	22·4	28·3	35·7
XVIII.	22·1	10·3	10·0	9·3	8·2	8·2	13·0	10·1	12·0	12·2	14·7	18·7
XIX.	22·4	15·7	7·2	11·7	16·8	15·7	15·6	7·1	15·5	12·5	18·0	19·5
XX.	9·8	7·2	11·6	7·6	–	–	–	–	20·7	–	9·4	8·2
XXIII.	18·6	14·9	13·2	9·8	9·9	10·6	14·1	13·9	11·0	16·7	20·0	22·6
XXIV.	16·7*	–	4·3*	4·7	–	1·9*	2·5	3·2	4·5	14·8	13·3	9·9
XXV.	–	16·7*	–	–	3·7	–	1·4*	30·0*	19·6	13·8	15·0	8·9
XXVI.	–	–	8·3*	–	–	–	–	13·1	13·7	15·4	12·6	9·2
XXVIII.	45·5*	37·8	30·4	–	22·2*	10·3	13·9	26·1	16·6	30·1	33·0	30·9
XXIX.	13·0	10·2	11·1	11·1	9·7	14·7	12·8	12·8	16·6	20·0	23·6	17·2
XXX.	–	8·8*	–	–	–	23·9*	–	23·0	16·4	14·8	15·4	–
XXXI.	–	–	–	–	–	–	12·7	19·5	18·7	14·4	10·9	–
XXXII.	–	–	–	–	–	–	10·3	13·9	17·3	–	8·9	9·8*
C.	49·8	50·9	39·3	51·2	42·1	43·4	50·8	29·5	83·1	30·9	36·6	203·7
D.	120·8	79·2	85·4	53·4	–	34·8	30·7	–	59·7	39·2	51·0	129·5
J.	19·4*	54·3	30·9*	–	37·4	38·2	–	38·8	–	–	50·0*	20·8*
K.	19·8	75·8	38·3	32·0	46·4	–	16·3	40·6	–	–	–	29·2*
Var. N. Sea	39·2	25·4	29·0	27·7	46·7	49·8	54·8	36·3	19·5	18·5	18·3	27·1
C.D. Minch	68·0	38·7	40·0	38·2	38·5	63·9	47·1	36·2	30·7	23·2	30·6	76·4
Western Grounds	39·4	45·7	43·7	49·0	37·2	41·3	33·1	39·2	21·2	23·6*	24·1	35·2
Faroe	183·3	219·9	250·5	309·4	137·0	109·3	140·8	159·7	167·5	115·7	88·8	103·4
Iceland	101·9	80·9	135·5	109·3	228·8	238·5	55·6	50·1	33·5	18·3	17·8	36·2

Area VII., Apr. 17·8, May 23·0*, Nov. 12·8*; VIII., Apr. 10·0, May 14·0, July 22·5, Aug. 20·6; XXII., Jan. 8·0*, Feb. 7·6, Dec. 14·3*; XXVII., July 28·3*, Aug. 14·6, Sept. 37·8; XXXIII., Aug. 26·4; XXXIV., Dec. 19·0*; XXXV., Aug. 13·8*, Sept. 12·5, Oct. 16·4, Nov. 45·7; XXXVI., Sept. 2·1*, Oct. 2·8*; XL., Sept. 10·4; XLIII., Sept. 1·7*; M., Feb. 52·1*, May 6·0, Aug. 8·3, Sept. 16·1*; L., July 42·6*; S., June 83·3*, Nov. 37·2*; Minch, Jan. 13·7, Mar. 56·3, Apr. 36·8, July 13·5*; Rockall, June 165·1*; Norway, Apr. 225·0, May 57·7, Nov. 2449·6*; White Sea, Aug. 588·2, Sept. 112·6, Oct. 144·0, Dec. 749·7*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Ling**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	53·1	80·8	34·4	85·6	66·6	–	–	–	–	62·9	113·7	–
IX.	–	–	–	4·8*	65·9	27·5	35·3	29·6	7·1*	13·3*	–	–
X.	35·6	33·5	15·8	46·6	25·3	13·4	26·1	10·0	39·0	46·3	53·7	12·8
XI.	13·8	22·2	29·0	28·4	51·8	67·5	106·9*	91·8	–	–	114·8*	106·7
XII.	–	17·4	23·7	31·0	25·0*	95·8*	95·8	114·6	19·8	–	–	–
XIII.	18·0	7·5	2·7	3·0	10·8	14·0	38·3	2·5	31·2	34·0	33·4	4·1
XIV.	11·7	18·4	10·1	17·3*	18·2	11·1	23·7	13·6	31·7	30·1	23·4	15·2
XV.	10·5	17·2	19·9	30·3	8·2	40·2*	–	6·4	127·8*	26·8	10·3	11·0
XVI.	5·5	7·9	16·3	22·2	–	–	–	–	–	–	4·6	7·6
XVII.	3·9	4·4	2·6	3·7	4·3	6·9	4·3	2·1	5·0	2·5	2·3	3·8
XVIII.	12·3	13·6	8·4	6·9	7·6	18·9	19·8	28·4	23·0	21·0	16·9	11·5
XIX.	7·2	12·2	4·6	5·5	14·4	6·6	9·9	25·2	15·4	7·1	10·6	6·4
XX.	5·5	9·5	20·6	12·9	–	–	–	–	8·7	–	4·5	4·8
XXIII.	3·6	4·5	2·8	3·7	4·4	6·4	9·0	8·5	10·2	6·7	4·6	2·7
XXIV.	20·8*	–	16·3*	5·6	–	12·5*	8·1	5·6	14·4	12·0	7·7	6·4
XXV.	–	·0*	–	–	2·0	–	·0*	1·1*	3·8	4·2	4·0	3·5
XXVI.	–	–	8·8*	–	–	–	–	2·7	2·3	1·9	3·4	5·6
XXVIII.	3·6*	3·1	1·1	–	7·3	6·7	2·1	1·4	·7	·8	1·6	1·5
XXIX.	2·5	1·6	1·2	1·2	4·0	3·6	3·2	2·8	1·9	3·1	1·9	2·6
XXX.	–	5·5*	–	–	–	14·8*	–	9·0	12·4	5·5	7·4	–
XXXI.	–	–	–	–	–	–	3·5	5·2	4·4	2·8	1·9	–
XXXII.	–	–	–	–	–	–	2·4	2·8	2·5	–	1·6	1·1*
C	·9	16·9	9·4	47·3	23·6	21·5	26·8	26·3	11·9	20·7	42·9	1·1
D.	2·4	3·0	4·2	4·1	–	10·5	9·5	–	2·2	·8	1·4	2·8
J.	1·7*	156·9	1·1*	–	18·4*	9·0	–	13·9	–	–	·0*	·0*
K.	49·3	191·1	55·6	50·3	23·8	–	24·9	9·4*	–	–	–	1·7*
Var. N. Sea.	14·2	16·5	15·6	37·3	16·0	11·8	16·8	16·9	12·5	18·7	14·8	12·5
C.D. Minch	5·1	8·0	2·6	5·7	11·8	31·7	9·0	1·2	8·2	12·7*	9·8	5·2
Western Grounds	25·4	35·6	17·2	48·3	15·6	13·0	5·9	4·3	10·5	·4	3·8	2·2
Faroe	·8	1·3	1·8	2·4	8·2	·8	2·2	2·7	3·4	2·4	1·4	1·1
Iceland	39·8	16·1	12·5	31·3	16·4	3·0	8·0	8·6	17·4	9·0	9·5	14·5

Area VII., Apr. 74·6, May 65·0*, Nov. 159·1*; VIII., Apr. 22·9, May 44·4, July 116·1, Aug. 154·0; XXII., Jan. 1·4*, Feb. 3·0, Dec. 2·4*; XXVII., July 2·2*, Aug. 2·8, Sept. 5·3; XXXIII., Aug. 5·6; XXXIV., Dec. 2·4*; XXXV., Aug. 16·6*, Sept. 2·8, Oct. 3·5, Nov. 18·0; XXXVI., Sept. 1·6*, Oct. 0·0*; XL., Sept. ·8; XLIII., Sept. 0·0*; M., Feb. 7·9*, May 8·9, Aug. 9·4, Sept. 0·6*; L., July 0·9*; S., June 135·5*, Nov. 13·3*; Minch, Jan. 12·8, Mar. 6·9, Apr. 2·7, July 13·1*; Rockall, June 44·9*; Norway, Apr. 52·9, May 53·2, Nov. 0·0*; White Sea, Aug. 0·6, Sept. 0·0, Oct. 0·0, Dec. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Tusk**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	3·9	2·1	1·9	3·1	1·9	–	–	–	–	1·6	2·8	–
IX.	–	–	–	·0*	1·4	·1	·6	1·5	·0*	·0*	–	–
X.	2·5	1·0	·7	·5	·4	·1	·2	·1	·10	·9	2·1	·3
XI.	·4	1·6	1·4	1·6	2·9	1·5	3·9	1·4	–	–	5·0*	8·9*
XII.	–	·4	1·0	1·9	2·4*	2·1*	3·7	1·2	·0*	–	–	–
XIII.	·4	·1	·0	·0	·1	·0	·0*	·0	·0	·9	·5	·0
XIV.	·6	·8	·4	1·2*	·3	·1	·1	·4	1·2	1·0	1·0	·4
XV.	·6	·8	·9	1·2	1·7	2·2*	–	·8	2·8*	1·1	·6	·4
XVI.	·2	1·5	·9	·6	–	–	–	–	–	–	·2	·3
XVIII.	·5	·2	·0	·0	·0	·2	·5	·2	·6	·7	·4	·5
XIX.	·5	·6	·7	·1	1·6	1·4	·5	·2	·7	·7	·7	·4
XX.	·6	·7	1·2	·4	–	–	–	–	·0	–	·0	·2
XXIV.	–	–	·0*	·0	–	·0*	·0	·1	·0	·1	·0	·1
XXVI.	–	–	·4*	–	–	–	–	·0	·0	·0	·1	·0
XXIX.	·0	·1	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0
XXX.	–	·2*	–	–	–	·2*	–	·0	·0	·0	·0	–
C.	·0	·8	·0	·3	·2	·1	·0	·0	·0	·1	1·9	·0
J.	·0*	1·1	·0*	–	·0*	·0	–	·0	–	–	·0*	·0*
K.	·0	2·5	·1	·5	·0	–	·0	·0*	–	–	–	·0*
Var. N. Sea	·8	·6	·6	1·0	·4	·3	·2	·2	·2	·5	·4	·5
C.D. Minch	·1	·0	·0	·0	·1	·0	·0	·0	·0	·4	·3	·0
Western Grounds	·0	·2	·1	·3	·3	·0	·0	·0	·1	·0*	·4	·0
Faroe	·6	·2	·5	·7	·8	·1	·0	·2	·2	·7	·4	·5
Iceland	·0	·0	·0	·0	·1	·0	·0	·0	·0	·2	·0	·0

No Tusk recorded from Areas XVII., XXII., XXIII., XXV., XXVII., XXVIII., XXXI.–XLIII., D., L., M., N., Minch, White Sea.

Area VII., Apr. 3·7, May 16·0*, Nov. 4·2*; VIII., Apr. 1·9, May 2·6, July 4·4, Aug. 1·7; S., June 2·2*, Nov. 0·0*; Rockall, June 5·1*; Norway, Apr. 0·0, May 0·2, Nov. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Saithe,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	299·4	443·3	151·3	111·7	96·5	–	–	–	–	46·2	23·5	–
IX.	–	–	–	104·8*	33·0	30·0	37·8	20·0	12·7	8·3	–	–
X.	157·4	154·5	128·6	133·7	85·6	50·8	27·0	17·7	25·5	38·0	16·9	10·0
XI.	84·8	174·6	88·4	56·5	83·5	131·8	18·2	40·2	–	–	17·4*	48·9*
XII.	–	286·2	55·3	32·0	19·0*	158·3*	69·4	53·4	15·4*	–	–	–
XIII.	27·0	11·0	8·2	11·1	80·3	50·4	65·0*	3·7	56·2	131·9	39·3	6·8
XIV.	71·3	55·3	23·1	11·9*	93·6	34·2	25·8	25·1	51·4	75·3	64·4	42·1
XV.	35·6	61·5	45·1	20·1	24·9	63·0*	–	275·8	97·2*	133·4	17·5	45·0
XVI.	28·9	172·2	51·5	55·4	–	–	–	–	–	–	4·2	6·6
XVII.	4·9	·9	4·3	4·3	12·0	10·7	7·0	3·6	2·1	6·4	1·6	2·9
XVIII.	32·7	7·1	3·8	4·0	5·8	75·6	156·7	91·8	38·2	36·7	29·2	47·8
XIX.	38·8	32·6	14·0	9·1	24·9	48·1	186·2	105·2	81·2	48·6	48·8	51·7
XX.	15·4	35·6	34·3	22·2	–	–	–	–	4·6	–	10·5	8·6
XXIII.	1·7	1·0	1·2	4·3	3·6	3·9	29·7	24·9	23·1	5·4	2·0	2·4
XXIV.	·0*	–	7·1*	6·6	–	2·3*	27·5	51·0	83·5	73·2	18·0	2·0
XXV.	–	·3*	–	–	7·4	–	·0*	·7*	7·7	7·0	8·5	49·8
XXVI.	–	–	21·1*	–	–	–	–	4·9	4·5	10·2	14·5	15·8
XXVIII.	·9*	·8	·6	–	·9*	1·7	·1	·2	·1	·1	·1	·6
XXIX.	·6	·2	·4	1·1	3·5	1·2	1·7	·5	·5	·1	·1	·6
XXX.	–	8·8*	–	–	–	20·4*	–	3·4	27·1	16·8	6·1	–
XXXI.	–	–	–	–	–	–	37·4	6·7	11·5	6·7	3·5	–
XXXII.	–	–	–	–	–	–	3·0	4·7	6·7	–	5·7	1·6*
C.	13·6	30·9	52·1	106·2	77·8	66·0	52·4	13·1	11·9	11·4	25·2	13·1
D.	12·4	10·1	21·4	35·6	–	16·9	4·3	–	2·7	1·7	1·8	5·3
J.	12·8*	145·6	8·4*	–	296·4*	65·9	–	60·6	–	–	15·0*	5·6*
K.	72·8	235·6	137·3	109·9	77·4	–	2·0	8·3*	–	–	–	4·2*
Var. N. Sea	59·4	53·8	65·2	78·6	55·3	42·0*	48·4	37·6	18·6	33·0	21·4	26·2
C.D. Minch	14·7	13·5	6·3	15·4	39·3	42·7	12·2	2·5	1·7	124·7	21·4	4·0
Western Grounds	27·1	55·3	76·0	94·3	89·9	111·3	4·1	31·0	4·8	1·8*	4·3	10·8
Faroe	7·1	22·8	21·7	40·2	36·7	24·2	29·9	28·2	12·1	17·2	2·5	3·5
Iceland	72·7	47·0	125·3	295·1	116·0	72·1	100·7	245·2	181·2	82·2	46·4	118·4

Area VII., Apr. 151·2, May 78·0*, Nov. 19·2*; VIII., Apr. 35·0, May 58·2, July 204·6, Aug. 68·9; XXII., Jan. 0·7*, Feb. 0·8, Dec. 2·4*; XXVII., July 1·1*, Aug. 3·1, Sept. 12·8; XXXIII., Aug. 22·9; XXXIV., Dec. 0·0*; XXXV., Aug. 18·7*, Sept. 21·7, Oct. 4·0, Nov. 43·7; XXXVI., Sept. 2·1*, Oct. 4·8*; XL., Sept. 6·3; XLIII., Sept. 0·0*; M., Feb. 4·8*, May 12·0, Aug. 42·4, Sept. 1·2*; L., July 14·8*; S., June 153·4, Nov. 8·9*; Minch, Jan. 17·1, Mar. 26·7, Apr. 6·2, July 408·3; Rockall, June 3·8*; Norway, Apr. 478·6, May 209·2, Nov. 0·0*; White Sea, Aug. 1·4, Sept. 0·0, Oct. 0·0, Dec. 1·1*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Hake**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	18·1	3·8	3·9	10·9	8·0	–	–	–	–	35·8	73·3	–
IX.	–	–	–	·0*	·8	1·6	·7	2·1	2·8*	5·0*	–	–
X.	3·6	1·0	·7	1·0	1·6	1·4	·6	1·4	15·4	27·7	37·2	4·3
XI.	1·5	·3	·6	1·4	5·2	1·0	2·3	1·0	–	–	50·0*	106·0*
XII.	–	2·2	·8	1·2	5·3*	2·1*	·6	·4	1·7*	–	–	–
XII.	1·0	·2	·0	·0	1·0	7·9	26·3*	27·6	13·6	27·3	38·0	4·5
XIV.	1·6	·6	·2	·7*	1·9	2·7	·8	4·9	6·9	9·4	6·7	5·3
XV.	1·7	·5	·7	·3	1·1	3·3*	–	·0	30·1*	7·0	1·5	2·3
XVI.	1·1	·0	·2	1·0	–	–	–	–	–	–	·5	1·8
XVII.	·0	·0	·0	·0	·6	13·6	15·1	20·9	6·8	1·2	·2	·0
XVIII.	1·1	·3	·1	·0	·5	2·2	·4	·3	3·7	5·3	5·5	2·6
XIX.	·8	·4	·1	·1	2·0	1·5	·1	·1	1·1	1·4	1·9	·7
XX.	·1	·0	·0	·2	–	–	–	–	·0	–	·2	·3
XXIII.	·1	·0	·0	·0	·1	·5	·4	·2	·4	·7	·3	·0
XXIV.	·0*	–	·0*	·0	–	·6*	·2	·1	·1	·1	·2	·3
XXV.	–	·0*	–	–	·2	–	·0*	1·9*	·1	·3	·6	·3
XXVI.	–	–	·0*	–	–	–	–	·3	·1	·5	·2	·3
XXVIII.	·0*	·0	·0	–	·0*	·0	·8	·4	·2	·1	·0	·0
XXIX.	·0	·0	·0	·0	·0	·5	·2	·1	·1	·0	·1	·0
XXX.	–	·2*	–	–	–	·5*	–	·0	·1	·1	·0	–
XXXI.	–	–	–	–	–	–	·1	·1	·1	·2	1·0	–
XXXII.	–	–	–	–	–	–	·1	·1	·0	–	·7	·2*
C.	·0	·1	·0	·1	·1	·7	3·2	·8	·7	2·4	33·8	·3
D.	·0	·0	·0	·0	–	1·0	·0	–	·0	·0	·2	·2
J.	·0*	·2	·0*	–	·2*	1·3	–	12·1	–	–	10·8*	·3*
K.	3·4	·7	·1	·0	4·0	–	2·0	1·9*	–	–	–	·0*
Var. N. Sea	1·8	1·0	·7	2·3	1·8	2·5	3·9	2·1	2·8	7·4	8·2	4·2
C.D. Minch	·1	·1	·0	·0	·6	3·7	2·5	3·8	1·0	8·7	13·3	·8
Western Grounds	2·1	2·5	·1	·1	·7	·6	2·3	·1	6·5	·7*	·9	3·7
Faroe	·0	·0	·0	·0	·2	·0	·0	·0	·2	·1	·0	·0

No Hake recorded from Areas XXII., XXXIV., XXXVI., L., Rockall, Norway, Iceland, White Sea.

Area VII., Apr. 4·9, May 2·7*, Nov. 87·2* ; VIII., Apr. 0·6, May 2·6, July 0·4, Aug. 3·1 ; XXVII., July 0·1*, Aug. 0·1, Sept. 0·1 ; XXXIII., Aug. 0·3 ; XXXV., Aug. 0·0*, Sept. 0·0, Oct. 0·0, Nov. 0·1 ; XL., Sept. 0·1 ; XLIII., Sept. 0·0* ; M., Feb. 0·0*, May 113·0, Aug. 48·0, Sept. 1·2* ; S., June 14·2*, Nov. 8·9* ; Minch, Jan. 82·9, Mar. 0·1, Apr. 4·4, July 79·2*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Extra Large Haddocks**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI. . .	3·5	4·6	3·4	8·2	1·1	–	–	–	–	1·7	2·0	–
IX. . .	–	–	–	16·7	4·8	6·7	3·0	·8	·8*	1·7*	–	–
X. . .	5·5	5·8	5·3	6·6	4·1	3·2	3·2	3·4	5·1	2·1	1·4	2·2
XI. . .	·0	·5	·7	1·3	·9	3·7	5·7	4·1	–	–	1·2*	·0*
XII. . .	–	·4	1·1	·4	·0*	4·8*	3·2	4·5	·0*	–	–	–
XIII. . .	1·5	·7	·6	·2	1·6	1·4	35·0*	·2	·0	·2	1·4	·4
XIV. . .	2·1	1·3	2·5	·0*	2·1	2·2	3·8	·7	1·2	·2	·7	2·0
XV. . .	·1	·4	·8	·5	·0	·0*	–	·0	·0*	·0	·0	·0
XVI. . .	·1	3·2	3·0	1·6	–	–	–	–	–	–	·0	·6
XVII. .	·3	·1	·1	·3	·1	1·5	·2	·2	·0	·1	·0	·2
XVIII. .	·0	·1	·1	·0	·0	·0	·0	·0	·0	·0	·0	·1
XIX. . .	·0	1·7	6·3	·1	·0	·0	·0	·0	·0	·0	·2	·2
XX. . .	·2	3·8	3·4	2·7	–	–	–	–	7·1	–	·3	·4
XXIII. .	·0	·1	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0
XXIV. .	·0*	–	4·3*	·7	–	·0*	·0	·0	·0	·0	·1	·0
XXV. .	–	·8*	–	–	·0	–	·0*	2·9*	4·6	1·4	·2	·9
XXVI. .	–	–	21·0*	–	–	–	–	5·4	3·7	4·5	·9	·2
XXVIII. .	·0*	·0	·0	–	·0*	·0	·0	·0	·0	·0	·0	·0
XXIX. .	·0	·0	·0	·0	·0	·0	·0	·1	·0	·0	·0	·0
XXX. .	–	·0*	–	–	–	·0*	–	1·1	·2	·0	·0	–
XXXI. .	–	–	–	–	–	–	·0	2·1	4·4	1·9	2·2	–
XXXII. .	–	–	–	–	–	–	2·8	8·9	5·5	–	3·0	·8*
C. . .	7·5	8·0	5·2	11·3	8·4	7·2	4·7	3·3	4·0	2·5	3·5	3·2
D. . .	11·0	5·7	3·1	6·1	–	4·6	6·4	–	12·4	2·3	1·7	2·4
J. . .	16·7*	5·9	4·2*	–	15·8*	3·0	–	4·8	–	–	8·3*	6·9*
K. . .	3·7	7·2	5·7	15·4	4·2	–	4·7	9·4*	–	–	–	8·3*
Var. N. Sea .	2·1	·9	1·5	2·9	1·8	1·5	1·2	1·1	1·8	·7	·6	·6
C.D. Minch .	5·1	2·1	·6	4·5	4·6	6·5	3·9	3·0	1·4	1·1	1·0	1·0
Western Grounds .	2·5	3·5	2·1	9·7	11·9	5·2	2·8	7·0	·64	7·1*	7·0	3·5
Faroe . .	19·8	23·6	21·3	29·0	21·6	22·9	27·5	23·3	9·6	5·4	16·1	9·7
Iceland .	47·4	52·7	140·9	112·3	113·7	131·6	59·0	36·4	30·5	19·6	25·3	36·6

No Extra Large Haddock recorded from Areas XXII., Rockall.

Area VII., Apr. 3·1, May 2·3, Nov. 0·0*; VIII., Apr. 3·4, May 2·2, July 6·6, Aug. 3·6; XXVII., July 0·9*, Aug. 27·7, Sept. 5·3; XXXIII., Aug. 13·9; XXXIV., Dec. 0·0*; XXXV., Aug. 0·0*, Sept. 0·2, Oct. 0·6, Nov. 0·0; XXXVI., Sept. 0·0*, Oct. 0·3*; XL., Sept. 0·7; XLIII., Sept. 0·0*; M., Feb. 0·0*, May 0·0, Aug. 0·5, Sept. 1·2*; L., July 1·5*; S., June 11·7*, Nov. 1·4*; Minch, Jan. 0·0, Mar. 4·7, Apr. 2·1, July 0·0*; Norway, Apr. 43·6, May 10·7, Nov. 493·7*; White Sea, Aug. 25·7, Sept. 410·3, Oct. 325·8, Dec. 632·5*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Large Haddocks,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	20·3	21·9	24·5	48·8	31·5	–	–	–	–	17·1	12·9	–
IX.	–	–	–	56·2*	26·8	39·9	35·2	38·7	94·9*	36·7*	–	–
X.	42·9	35·2	36·8	43·1	32·2	41·4	37·2	44·2	52·5	15·2	11·8	14·2
XI.	44·1	40·5	47·8	66·7	47·0	76·7	75·6	48·8	–	–	10·2*	15·5*
XII.	–	44·6	46·1	49·4	2·4*	103·1*	54·6	62·0	·0*	–	–	–
XIII.	19·2	20·7	13·7	9·3	12·9	22·8	99·7*	22·5	5·9	7·3	12·4	17·4
XIV.	32·1	26·3	24·9	16·7*	22·3	30·6	35·8	28·7	18·7	11·0	21·4	25·2*
XV.	29·1	40·0	41·6	22·8	5·2	·3*	–	1·1	6·9*	8·8	17·0	9·9
XVI.	28·5	67·9	52·1	66·7	–	–	–	–	–	–	22·0	43·4
XVII.	7·0	12·5	9·9	14·7	4·6	7·9	9·5	19·5	12·6	14·9	15·0	19·2
XVIII.	13·8	11·7	8·8	4·9	1·5	·4	·4	·5	1·2	2·5	1·5	6·1
XIX.	22·1	30·8	63·8	15·1	3·3	1·1	·5	·6	8·4	1·6	16·0	15·3
XX.	51·9	71·3	53·7	56·5	–	–	–	–	85·2	–	36·3	37·6
XXIII.	5·6	7·3	4·6	13·5	2·3	2·6	4·1	5·2	3·2	5·5	4·0	4·3
XXIV.	20·8	–	22·1*	11·9	–	1·0*	1·1	·7	·9	8·9	13·8	15·9
XXV.	–	4·4*	–	–	4·9	–	11·1*	45·7*	68·3	44·7	38·5	28·0
XXVI.	–	–	143·4*	–	–	–	–	78·6	54·2	88·9	29·0	63·1
XXVIII.	3·6*	4·0	2·0	–	1·6*	2·3	3·4	5·9	5·3	8·5	8·5	4·2
XXIX.	4·4	4·0	4·2	4·8	2·9	3·7	3·6	5·0	6·7	8·1	8·4	5·1
XXX.	–	3·3*	–	–	–	1·1*	–	26·3	32·6	17·3	18·8	–
XXXI.	–	–	–	–	–	–	44·0	63·4	52·5	46·9	46·3	–
XXXII.	–	–	–	–	–	–	53·0	76·9	70·3	–	49·3	27·8*
C.	48·8	83·0	36·0	66·9	58·9	58·5	54·7	54·0	70·2	53·6	59·8	65·9
D.	42·9	29·6	24·8	47·2	–	25·9	40·6	–	252·7	120·2	14·7	32·5
J.	455·6*	75·9	84·6*	–	93·5*	34·9	–	77·6	–	–	445·8*	100·8*
K.	5·5	53·2	30·8	84·2	21·1	–	66·6	112·3*	–	–	–	233·3*
Var. N. Sea	29·6	21·5	28·0	27·4	18·3	19·5	15·9	17·7	24·3	14·8	18·4	14·2
C.D. Minch	26·3	11·9	13·4	34·6	35·9	42·0	33·0	46·0	30·3	29·4	35·7	21·8
Western Grounds	7·6	19·3	12·7	50·4	84·8	61·6	39·5	78·3	72·7	139·2	* 102·8	67·0
Faroe.	64·6	33·6	45·3	37·6	36·4	100·3	91·5	82·4	54·0	38·2	51·0	30·4
Iceland	5·8	4·8	14·0	11·6	17·1	42·5	16·0	11·7	9·4	5·0	1·2	2·1

Area VII., Apr. 62·5, May 24·0*, Nov. 5·1*; VIII., Apr. 33·7, May 30·5, July 66·6, Aug. 74·6; XXII., Jan. 6·5*, Feb. 10·5, Dec. 4·4*; XXVII., July 33·5*, Aug. 117·6, Sept. 80·1; XXXIII., Aug. 42·5; XXXIV., Dec. 4·8*; XXXV., Aug. 11·0*, Sept. 1·7, Oct. 10·3, Nov. 33·0; XXXVI., Sept. 5·1*, Oct. 1·1*; XL., Sept. 4·6; XLIII., Sept. 6·0*; M., Feb. 7·1*, May ·5, Aug. 31·9, Sept. 109·2*; L., July 31·5*; S., June 41·7*, Nov. 2·2*; Minch, Jan. 3·5, Mar. 33·2, Apr. 33·2, July 0·0*; Rockall, June 54·5*; Norway, Apr. 325·3, May 213·0, Nov. 0·0*; White Sea, Aug. ·9, Sept. 8·0, Oct. 1·6, Dec. 14·1*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Medium Haddocks**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	7·6	9·7	10·9	24·8	16·0	–	–	–	–	8·5	5·4	–
IX.	–	–	–	21·4*	9·2	13·6	11·2	17·6	28·6*	21·7*	–	–
X.	13·5	17·1	15·7	20·1	13·0	12·9	12·7	14·3	17·0	8·0	5·7	5·7
XI.	27·6	21·6	23·1	36·5	25·0	19·4	18·4	18·4	–	–	4·1*	6·7*
XII.	–	19·8	18·7	28·7	3·0*	33·9*	13·3	18·1	1·9*	–	–	–
XIII.	8·2	20·8	11·5	9·0	6·1	8·6	49·2*	10·7	6·1	9·5	9·2	13·2
XIV.	16·6	16·9	12·7	14·9*	6·5	10·9	9·8	12·6	9·7	5·9	9·1	8·5
XV.	22·0	24·1	25·2	24·6	12·1	2·0*	–	·8	13·9*	4·9	18·5	8·9
XVI.	19·7	23·9	19·9	28·0	–	–	–	–	–	–	13·1	22·4
XVII.	11·0	17·9	12·3	11·5	6·6	9·6	9·3	12·7	14·6	19·3	17·7	16·1
XVIII.	16·5	15·4	13·3	7·7	4·3	·9	·8	1·0	2·1	4·0	2·2	6·8
XIX.	21·9	15·7	27·8	16·0	9·1	4·9	1·6	2·4	7·1	2·1	10·5	11·9
XX.	22·7	29·4	24·1	24·8	–	–	–	–	25·9	–	17·8	18·9
XXIII.	5·9	6·7	3·5	4·6	3·8	4·1	5·3	5·9	5·1	8·1	5·4	4·4
XXIV.	41·7	–	15·8*	9·3	–	·0*	2·8	2·6	3·1	9·4	14·7	17·9
XXV.	–	1·3*	–	–	4·3	–	6·9*	10·0*	26·7	21·5	22·7	20·3
XXVI.	–	–	51·1*	–	–	–	–	24·3	23·5	25·0	14·6	36·8
XXVIII.	2·7	1·4	·7	–	3·7*	5·3	5·4	7·9	5·1	5·8	5·5	2·1
XXIX.	4·5	3·4	3·1	4·7	6·5	3·9	5·5	6·4	7·9	8·7	7·0	5·6
XXX.	–	5·5*	–	–	–	9·1*	–	13·1	18·3	16·4	16·9	–
XXXI.	–	–	–	–	–	–	22·1	17·2	21·5	19·5	19·2	–
XXXII.	–	–	–	–	–	–	21·0	25·5	23·8	–	16·4	16·9*
C.	25·4	45·1	19·9	30·2	31·4	25·3	26·8	25·8	36·7	36·1	28·9	19·9
D.	22·3	18·9	10·2	30·1	–	12·3	19·8	–	118·8	35·8	13·1	20·9
J.	232·2*	36·5	30·5*	–	50·0*	17·7	–	32·1	–	–	125·0*	33·3*
K.	2·8	18·5	20·9	46·3	5·8	–	20·4	40·4*	–	–	–	81·7*
Var. N. Sea	16·0	14·8	14·6	15·5	8·6	8·0	8·2	9·6	11·4	9·8	10·7	9·7
C.D. Minch	14·7	10·0	10·5	17·9	19·7	21·3	18·6	17·1	19·6	18·2	20·9	12·3
Western Grounds	5·5	15·3	6·9	23·9	37·4	21·3	18·3	27·6	26·5	37·8*	39·3	20·9
Faroe	24·9	21·9	19·2	14·2	10·3	21·0	22·5	20·0	17·6	12·0	9·7	9·1
Iceland	·0	·1	·0	·0	·2	·0	·0	·1	·0	·1	·0	·0

Area VII., Apr. 30·4, May 9·0*, Nov. 2·1*; VIII., Apr. 20·3, May 18·7, July 11·7, Aug. 22·9; XXII., Jan. 11·3*, Feb. 12·5, Dec. 8·4*; XXVII., July 15·4*, Aug. 23·9, Sept. 31·8; XXXIII., Aug. 26·3; XXXIV., Dec. 4·8*; XXXV., Aug. 13·1*, Sept. ·6, Oct. 5·8, Nov. 12·9; XXXVI., Sept. 0·0*, Oct. 0·0*; XL., Sept. 3·6; XLIII., Sept. 2·7*; M., Feb. 1·6*, May ·3, Aug. 21·6, Sept. 74·4*; L., July 5·5*; S., June 18·3*, Nov. 0·0*; Minch, Jan. 1·6, Mar. 15·3, Apr. 11·9, July 0·0*; Rockall, June 41·0*; Norway, Apr. 45·3, May 31·4, Nov. 0·0*; White Sea, Aug. 0·0, Sept. 0·0, Oct. 0·0, Dec. 1·9*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Small Haddocks,** in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI. . .	10·0	6·7	12·6	33·0	21·1	–	–	–	–	16·3	11·7	–
IX. . .	–	–	–	14·3*	14·2	8·6	12·8	21·8	28·2*	28·3*	–	–
X. . .	13·6	25·2	20·8	25·4	16·2	10·3	10·7	17·9	29·1	19·9	12·7	16·7
XI. . .	51·8	33·8	28·4	49·8	27·4	15·7	15·4	13·9	–	–	9·9*	12·2*
XII. . .	–	24·1	25·0	31·0	27·4*	12·5*	12·3	13·9	18·3*	–	–	–
XIII. .	10·7	59·7	30·2	21·9	9·2	11·5	77·5*	21·6	18·1	19·7	14·1	15·3
XIV. . .	33·3	39·1	34·7	35·1*	13·4	12·1	12·6	19·5	19·6	16·1	15·5	13·2
XV. . .	44·4	41·4	36·1	61·2	31·4	10·9*	–	21·7	41·7*	18·8	27·0	21·6
XVI. . .	44·9	42·5	32·0	26·6	–	–	–	–	–	–	22·3	35·7
XVII. .	41·0	51·2	38·7	31·2	15·3	21·7	25·9	18·9	27·9	31·6	24·6	17·1
XVIII. .	48·9	48·3	45·5	39·9	18·0	27·4	17·8	22·8	18·8	17·8	12·9	16·1
XIX. .	47·0	38·7	62·8	44·7	22·9	17·8	24·9	15·9	17·4	13·8	20·9	24·5
XX. . .	40·0	61·6	36·3	34·0	–	–	–	–	30·7	–	24·6	35·6
XXIII. .	16·7	16·2	11·1	15·5	15·0	16·1	16·7	18·2	21·5	20·7	14·9	10·5
XXIV. .	54·2*	–	69·4*	33·6	–	5·4*	15·5	15·3	18·0	24·5	27·8	35·3
XXV. .	–	3·2*	–	–	6·2	–	5·0*	12·9*	26·0	24·6	28·0	42·5
XXVI. .	–	–	40·8*	–	–	–	–	23·5	21·9	23·8	14·3	25·8
XXVIII. .	3·2*	1·0	1·0	–	8·4*	6·6	7·6	12·5	10·8	12·6	14·1	5·6
XXIX. .	10·4	4·9	4·6	9·6	20·5	14·2	13·2	16·5	15·3	17·9	17·1	14·1
XXX. .	–	35·0*	–	–	–	48·9*	–	21·3	29·3	21·3	25·9	–
XXXI. .	–	–	–	–	–	–	30·1	24·4	22·1	20·6	19·6	–
XXXII. .	–	–	–	–	–	–	31·3	23·1	18·5	–	13·5	19·2*
C. . .	16·1	43·5	28·6	43·7	37·4	25·0	30·	25·9	33·2	49·3	39·7	11·9
D. . .	15·6	18·1	15·6	48·9	–	10·5	18·1	–	59·7	7·3	9·9	16·4
J. . .	166·7*	32·3	26·1*	–	56·1*	24·9	–	34·4	–	–	158·3	54·2*
K. . .	15·9	22·9	34·5	58·4	35·1	–	31·5	35·4*	–	–	–	70·8*
Var. N. Sea .	29·4	31·2	26·9	25·4	15·1	12·5	19·3	21·9	19·0	20·0	18·8	18·8
C.D. Minch .	15·2	19·3	30·4	27·1	25·1	22·6	22·1	20·7	23·3	19·2	25·4	13·1
Western Grounds .	7·5	19·0	15·3	30·2	46·4	20·4	23·3	22·7	17·5	16·7*	59·3	24·2
Faroe . .	32·7	16·2	16·9	11·4	14·0	19·3	18·3	12·8	13·1	13·3	4·8	5·7
Iceland .	·0	·0	·0	·0	·0	·0	·2	1·3	3·0	8·1	4·6	·2

Area VII., Apr. 48·6, May 12·3*, Nov. 6·2* ; VIII., Apr. 24·1, May 23·2, July 17·8, Aug. 18·9 ; XXII., Jan. 55·8*, Feb. 41·6, Dec. 20·6* ; XXVII., July 24·0*, Aug. 16·4, Sept. 12·2 ; XXXIII., Aug. 24·6 ; XXXIV., Dec. 21·4* ; XXV., Aug. 17·3*, Sept. 9·0, Oct. 9·0, Nov. 12·1 ; XXXVI., Sept. 5·6*, Oct. ·6* ; XL., Sept. 16·7 ; XLIII., Sept. 1·7* ; M., Feb. 3·2*, May ·9, Aug. 17·7, Sept. 12·8* ; L., July 7·4* ; S., June 25·0*, Nov. 0·0* ; Minch, Jan. 8·5, Mar. 31·3, Apr. 21·2, July 10·4* ; Rockall, June 85·2* ; Norway, Apr. 34·4, May 19·6, Nov. 0·0* ; White Sea, Aug. 6·7, Sept. 0·0, Oct. 0·0, Dec. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Extra Small Haddocks**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·0	·0	1·7	4·4	5·2	–	–	–	–	2·1	·0	–
IX.	–	–	–	·0*	·0	3·3	·2	·0	·0*	8·3*	–	–
X.	·2	2·2	2·2	3·0	2·6	·9	·6	·2	·6	4·0	1·0	·5
XI.	21·3	9·3	6·9	14·2	5·7	·3	·0	·0	–	–	·0*	11·1*
XII	–	1·9	3·4	7·6	·0*	·0*	·7	·5	14·4*	–	–	–
XIII.	·9	16·0	13·9	·0	1·9	2·6	5·8*	1·5	5·0	1·2	·5	1·0
XIV.	8·2	9·4	9·5	21·4*	2·2	·6	2·2	·0	3·0	3·7	3·7	1·8
XV.	16·7	13·9	12·1	10·8	17·0	17·9*	–	·0	12·5*	·9	·0	·8
XVI.	5·1	·7	4·2	9·6	–	–	–	–	–	–	8·6	11·3
XVII.	6·9	16·3	12·7	7·9	5·1	6·5	6·4	3·2	6·1	7·4	4·1	2·1
XVIII.	13·7	26·2	22·7	19·6	18·0	4·1	8·3	7·1	7·7	5·3	6·8	3·2
XIX.	17·0	12·7	24·0	13·4	11·6	7·1	6·3	9·4	4·9	·7	5·0	3·6
XX.	22·4	18·3	·0	21·5	–	–	–	–	1·0	–	2·7	3·7
XXIII.	8·8	9·0	4·8	9·2	8·9	9·1	8·1	9·2	11·6	11·4	6·3	4·8
XXIV.	·0*	–	13·0*	10·7	–	·0*	2·9	·0	2·4	2·2	5·5	5·2
XXV.	–	·0*	–	–	·5	–	·0*	20·0*	·4	1·9	4·4	7·7
XXVI.	–	–	31·6*	–	–	–	–	·0	2·0	·0	1·5	·0
XXVIII.	1·8	1·9	·0	–	1·7*	3·1	10·0	14·7	6·6	3·5	4·1	·0
XXIX.	5·3	1·3	1·3	3·4	4·9	9·0	13·1	12·4	16·3	14·2	9·3	7·1
XXX.	–	·0*	–	–	–	·0*	–	3·4	·8	5·9	4·7	–
XXXI.	–	–	–	–	–	–	4·1	·8	1·2	2·4	·6	–
XXXII.	–	–	–	–	–	–	1·8	1·5	·4	–	·5	4·7*
C.	·0	6·0	1·7	3·6	2·2	1·1	·7	·4	·0	·0	·0	·0
D.	·4	1·0	1·2	4·4	–	·7	·0	–	·0	1·7	1·2	1·9
J.	27·8*	·0	·0*	–	·0*	·0	–	·0	–	–	·0*	·0*
K.	·0	·0	·0	·8	·0	–	·0	·0*	–	–	–	·0*
Var. N. Sea	12·9	14·5	8·6	7·8	5·1	4·2	3·5	3·9	3·9	3·3	3·8	3·5
C.D. Minch	1·0	4·3	8·3	4·9	2·6	·8	2·1	2·3	3·5	·1	1·2	1·5
Western Grounds	5·3	·6	1·0	·0	3·0	·0	·0	·0	·0	·0*	·0	·0
Faroe	2·1	·8	·3	·1	·3	·4	·1	·5	1·1	1·0	·7	·0

No Extra Small Haddock recorded from Areas VII., XXXIV., XXXVI., XL., XLIII., L., M., S., Minch, Norway, Iceland, White Sea.

Area VIII., Apr. 4·1, May 0·0, July 1·9, Aug. 0·0 ; XXII., Jan. 33·3*, Feb. 9·7, Dec. 8·4* ; XXVII., July 3·6*, Aug. ·3, Sept. 2·1 ; XXXIII., Aug. 2·1 ; XXXIV., Dec. 0·0* ; XXXV., Aug. 0·0*, Sept. 0·0, Oct. 3·0, Nov. 3·1 ; XXXVI., Sept. 0·0*, Oct. 0·0* ; Rockall, June 16·7*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Whiting**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	17·6	16·6	25·8	32·5	42·7	–	–	–	–	15·7	13·5	–
IX.	–	–	–	2·4*	3·3	2·7	2·2	6·8	6·3*	29·2*	–	–
X.	13·9	35·8	26·6	24·5	15·5	6·5	7·0	15·3	19·6	38·2	22·0	60·4
XI.	49·4	25·7	34·4	59·5	74·1	7·0	3·8	3·2	–	–	16·3*	39·6*
XII.	–	22·3	22·9	42·1	15·5*	5·8*	8·0	4·2	25·6*	–	–	–
XIII.	4·4	28·3	13·9	18·5	5·6	5·4	43·8*	24·6	13·9	9·3	5·5	18·4
XIV.	41·3	60·0	47·4	69·0*	9·7	4·5	6·9	9·7	14·7	21·0	27·6	31·6
XV.	35·5	42·2	39·3	59·6	40·7	13·0*	–	36·7	20·1*	23·6	40·7	40·6
XVI.	23·8	19·9	23·2	37·0	–	–	–	–	–	–	19·5	37·3
XVII.	8·5	10·2	6·8	13·7	14·6	33·7	44·9	26·0	32·0	40·1	24·4	12·2
XVIII.	38·1	21·8	19·5	18·0	17·3	23·1	25·1	30·2	29·3	40·5	31·2	36·4
XIX.	37·5	25·9	44·3	33·9	21·8	16·8	24·9	23·5	23·1	26·1	31·0	31·7
XX.	18·8	16·4	12·9	43·4	–	–	–	–	12·3	–	18·5	23·4
XXIII.	11·3	11·2	7·5	15·9	15·6	21·9	30·8	33·3	38·3	58·4	38·0	25·7
XXIV.	45·8*	–	29·1*	31·8	–	·0*	5·2	12·5	15·0	18·9	24·1	25·2
XXV.	–	13·2	–	–	3·4	–	·0*	2·1*	9·3	17·9	23·5	28·5
XXVI.	–	–	21·5*	–	–	–	–	5·2	7·4	14·9	11·6	17·7
XXVIII.	4·1*	·9	·9	–	4·8*	8·8	13·5	21·3	15·7	14·2	22·7	7·4
XXIX.	11·6	4·1	3·4	6·9	13·6	15·4	17·5	17·9	23·5	20·3	42·2	24·8
XXX.	–	13·8*	–	–	–	13·2*	–	6·0	12·4	24·7	25·1	–
XXXI.	–	–	–	–	–	–	5·9	9·3	9·4	18·9	11·2	–
XXXII.	–	–	–	–	–	–	2·8	6·3	6·5	–	11·3	15·3*
C.	15·4	54·4	19·0	5·2	5·3	6·6	10·9	21·2	22·3	10·8	20·4	18·8
D.	3·8	4·9	2·4	3·9	–	2·6	·6	–	1·8	·7	4·3	3·3
J.	444·5	45·1	35·8	–	1·7*	3·3	–	2·4	–	–	131·7*	100·0*
K.	·0	29·4	3·7	3·8	·3	–	6·0	2·1*	–	–	–	258·3*
Var. N. Sea	22·1	31·7	23·3	23·1	17·7	12·1	18·9	18·7	17·7	23·3	23·2	32·5
C.D. Minch	2·9	6·8	10·8	7·2	8·2	6·9	19·1	12·7	13·6	16·4	13·9	14·5
Western Grounds	1·2	9·7	2·7	3·4	4·2	5·5	7·5	5·1	2·5	30·9*	36·8	28·5
Faroe	·3	·1	·3	·3	1·4	6·7	5·0	5·7	7·7	2·4	1·0	·1
Iceland	·0	·1	·0	3·3	4·7	·7	3·3	1·5	·7	2·3	·0	·1

No Whiting recorded from Area S., Rockall, or White Sea.

Area VII., Apr. 78·4, May 26·5*, Nov. 18·1*; VIII., Apr. 40·3, May 75·0, July 12·4, Aug. 5·0; XXII., Jan. 16·7*, Feb. 14·5, Dec. 27·0*; XXVII., July 10·2*, Aug. 8·9, Sept. 10·0; XXXIII., Aug. 5·3; XXXIV., Dec. 20·5*; XXXV., Aug. 17·5*, Sept. 15·0, Oct. 16·7, Nov. 14·1; XXXVI., Sept. 0·0*, Oct. 5·6*; XL., Sept. 8·6; XLIII., Sept. 6·7*; M., Feb. 0·0*, May 4·3, Aug. 10·1, Sept. 0·0*; L., July 3·7*; Minch, Jan. ·8, Mar. 4·7, Apr. 2·2, July 13·1*; Norway, Apr. 103·6, May 3·7, Nov. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Turbot,** in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·0	·1	·2	·0	·1	–	–	–	–	·0	·0	–
IX.	–	–	–	1·4*	·1	·2	·1	·2	·2*	·2*	–	–
X.	·1	·2	·2	·1	·1	·2	·1	·3	·1	·1	·1	·2
XI.	·2	·0	·0	·1	·0	·6	·3	1	–	–	·0*	·0*
XII.	–	·0	·0	·1	·1*	·8*	·0	·1	·0*	–	–	–
XIII.	·1	·6	·6	·3	·7	·4	7·3*	2·5	·2	·1	·3	·5
XIV.	·1	·1	·3	·0*	·5	·2	·3	·7	·2	·0	·0	·1
XV.	·0	·0	·0	·0	·1	·1*	–	·1	·4*	·0	·0	·0
XVI.	·1	·0	·0	·0	–	–	–	–	–	–	·0	·0
XVII.	·1	·1	·2	·1	·2	·1	·2	·2	·1	·1	·1	·3
XVIII.	·1	·1	·1	·2	·2	·4	·3	·1	·1	·1	·0	·0
XIX.	·0	·0	·0	·1	·1	·1	·1	·2	·1	·0	·0	·0
XX.	·0	·1	·0	·0	–	–	–	–	·2	–	·1	·0
XXIII.	·4	1·0	·8	·9	·8	·4	·7	·6	·2	·4	·4	·6
XXIV.	·0*	–	·7*	·6	–	5·8*	2·4	1·9	·2	·1	·1	·0
XXV.	–	2·1*	–	–	3·7	–	1·7*	1·1*	·1	·1	·1	·0
XXVI.	–	–	·0*	–	–	–	–	·0	·1	·1	·1	·0
XXVIII.	1·4*	·1	·3	–	·1*	·2	·4	1·0	·7	·6	·5	·4
XXIX.	·1	1·4	1·2	1·0	·5	·4	·6	1·0	·7	·4	·5	·7
XXX.	–	·0*	–	–	–	·7*	–	·2	·2	·1	·0	–
XXXI.	–	–	–	–	–	–	·5	·0	·1	·0	·1	–
XXXII.	–	–	–	–	–	–	·7	·3	·1	–	·5	·0*
C.	·0	·1	·0	·1	·1	·1	·2	·1	·6	·7	·2	·5
D.	·4	1·0	·2	·1	–	·1	·3	–	1·8	·2	·2	·4
J.	·0*	·0	2·1*	–	·0*	·1	–	·3	–	–	·0*	·0*
K.	3·2	·8	·3	·2	·5	–	·6	·0*	–	–	–	2·5*
Var. N. Sea	·1	·1	·2	·1	·3	·2	·3	·4	·2	·1	·1	·1
C.D. Minch	·2	·1	·3	·2	·3	·3	·5	·7	·7	·2	·2	·3
Western Grounds	·5	·5	·2	·3	·1	·0	·3	1·0	1·1	·1*	1·3	·1

No Turbot recorded from Areas VII., XXXVI., L., Faroe, Iceland, White Sea.

Area VIII., Apr. 0·0, May ·2, July ·1, Aug. ·1; XXII., Jan. ·4*, Feb. ·2, Dec. ·2*; XXVII., July ·9*, Aug. ·3, Sept. ·2; XXXIII., Aug. ·2; XXXIV., Dec. 1·9*; XXXV., Aug. ·1*, Sept. 0·0, Oct. 0·0, Nov. 0·0; XL., Sept. ·1; XLIII., Sept. 1·0*; M., Feb. 11·9*, May 0·0, Aug. 2·9, Sept. 4·5*; S., June ·5*, Nov. 1·4*; Minch, Jan. 0·0, Mar. ·2, Apr. 1·1, July ·2*; Rockall, June ·4*; Norway, Apr. ·4, May ·2, Nov. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Halibut,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	2·2	3·4	2·8	2·3	3·2	–	–	–	–	2·1	1·5	–
IX.	–	–	–	9·5*	4·3	3·1	4·8	4·6	2·4*	5·5*	–	–
X.	3·1	2·8	4·2	4·1	3·4	3·2	3·7	2·6	2·1	2·2	1·5	1·8
XI.	1·5	1·2	2·5	2·8	2·4	4·6	4·0	2·7	–	–	1·5*	3·3*
XII.	–	1·9	2·1	3·0	1·8*	6·2*	3·6	3·6	1·9*	–	–	–
XIII.	1·6	1·4	·6	·7	3·3	2·9	20·8	2·4	9·1	4·3	3·0	1·1
XIV.	1·5	1·3	1·8	1·8*	1·9	3·3	2·2	1·6	2·9	2·1	2·6	1·8
XV.	1·4	1·6	2·1	2·3	1·8	·9*	–	3·3	3·5*	1·4	2·2	1·5
XVI.	·5	·6	1·8	2·2	–	–	–	–	–	–	·6	1·5
XVII.	·9	·3	·3	·3	·8	1·1	1·0	1·0	1·1	·9	1·0	1·5
XVIII.	1·0	·4	·4	·4	·4	1·1	1·1	1·4	1·5	1·7	1·7	1·5
XIX.	1·1	1·1	1·2	·8	1·4	1·6	1·4	2·3	2·1	2·0	1·7	1·2
XX.	1·5	1·0	1·4	1·0	–	–	–	–	2·2	–	·8	·9
XXIII.	·2	·3	·3	·4	·5	·5	·6	·7	·8	·3	·4	·4
XXIV.	·0*	–	·5*	·7	–	·0*	·6	·5	1·2	1·2	1·1	1·2
XXV.	–	·0*	–	–	1·8	–	·8*	·7*	1·0	1·0	1·5	·5
XXVI.	–	–	·7*	–	–	–	–	1·3	1·0	·6	·7	1·1
XXVIII.	·5*	·1	·3	–	·5*	·3	·2	·3	·2	·3	·4	·6
XXIX.	·0	·2	·3	·2	·3	·5	·2	·3	·1	·1	·2	·3
XXX.	–	1·7*	–	–	–	·7*	–	1·8	1·0	·6	·8	–
XXXI.	–	–	–	–	–	–	·6	·6	·9	·6	·8	–
XXXII.	–	–	–	–	–	–	·7	1·6	1·0	–	·9	·8*
C.	1·5	5·9	4·3	2·5	4·6	4·0	2·7	3·2	3·6	1·8	1·3	3·8
D.	2·0	2·3	2·4	3·2	–	2·9	1·3	–	2·2	1·2	1·4	4·3
J.	13·9*	7·3	5·8*	–	10·2*	3·6	–	1·2	–	–	10·8	7·8*
K.	2·8	8·5	2·9	2·4	3·9	–	·7	3·1*	–	–	–	19·2*
Var. N. Sea.	1·5	1·4	1·9	2·3	2·4	2·5	1·9	1·6	1·4	1·3	1·2	1·3
C.D. Minch	1·7	1·0	·8	2·6	3·0	3·5	3·1	1·8	·7	3·2	1·9	1·8
Western Grounds	1·5	2·5	1·9	6·5	4·3	4·2	1·9	1·8	1·5	4·5*	2·2	2·3
Faroe	3·8	5·8	4·6	4·1	3·3	3·9	3·5	5·4	5·3	4·4	4·2	3·5
Iceland	7·1	2·3	2·3	1·7	5·1	7·8	5·7	4·4	5·5	5·6	4·6	2·5

Area VII., Apr. 2·8, May 4·5*, Nov. ·9*; VIII., Apr. ·9, May 4·1, July 3·1, Aug. 2·2; XXII., Jan. ·0*, Feb. ·0, Dec. ·8*; XXVII., July 1·6*, Aug. 2·0, Sept. 1·1; XXXIII., Aug. 1·1; XXXIV., Dec. 0·0*; XXXV., Aug. ·6*, Sept. ·1, Oct. ·3, Nov. 1·4; XXXVI., Sept. 0·0*, Oct. 0·0*; XL., Sept. ·7; XLIII., Sept. ·3*; M., Feb. ·5*, May ·9, Aug. ·7, Sept. 0·0*; L., July 2·4; S., June 5·5*, Nov. 1·1*; Minch, Jan. ·4, Mar. 2·9, Apr. 2·5, July 3·7*; Rockall, June 2·8*; Norway, Apr. 5·3, May 10·0, Nov. 2·1*; White Sea, Aug. ·4, Sept. 1·1, Oct. ·9, Dec. 7·8*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Brill**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·0	·0	·0	·0	·0	–	–	–	–	·0	·0	–
XIII.	·0	·0	·1	·0	·0	·1	·8*	·1	·1	·0	·0	·1
XIV.	·0	·0	·0	·1*	·0	·0	·0	·0	·0	·0	·0	·0
XVII.	·1	·1	·1	·0	·1	·1	·0	·0	·1	·1	·1	·2
XXIII.	·1	·0	·1	·0	·0	·0	·0	·0	·0	·0	·1	·1
XXIV.	·0*	–	·1*	·0	–	·0*	·0	·0	·0	·0	·0	·0
XXV.	–	·6*	–	–	·0	–	·0*	·0*	·0	·0	·0	·0
XXVI.	–	–	·1*	–	–	–	–	·0	·0	·0	·0	·0
XXVIII.	·2*	·1	·2	–	·0*	·0	·0	·0	·4	·2	·4	·2
XXIX.	·0	·0	·0	·0	·0	·0	·0	·0	·0	·1	·0	·0
XXXII.	–	–	–	–	–	–	·0	·0	·0	–	·1	·2*
C.	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0	·8
D.	·1	·4	·1	·1	–	·1	·0	–	·0	·2	·0	·3
J.	·0*	·0	1·4*	–	·0*	·0	–	·0	–	–	·0*	·0*
K.	·2	·0	·0	·0	·0	–	·0	·0*	–	–	–	·0*
C.D. Minch	·1	·1	·1	·0	·0	·1	·1	·1	·0	·0	·1	·2
Western Grounds	·2	·1	·1	·0	·0	·0	·1	·0	·3	·0*	·6	·0

No Brill recorded from Areas VI., VII., IX.–XII., XV., XVI., XVIII.–XXI., XXX., XXXI., XXXIII., XXXV., XXXVI., XL., L., S., Faroe, Iceland, Rockall, Norway, or White Sea.

Area VIII., Apr. 0·0, May ·1, July 0·0, Aug. 0·0; XXII., Jan. 0·0*, Feb. 0·0, Dec. ·2*; XXVII., July ·3*, Aug. 0·0, Sept., 0·0; XXXIV., Dec. ·5*; XLIII., Sept. ·3*; M., Feb. 3·5*, May 0·0, Aug. ·9, Sept. 3·0*; Minch, Jan. 0·0, Mar. ·5, Apr. ·1, July 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Large Lemons,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·1	·0	·1	·1	·1	–	–	–	–	·2	·1	–
IX.	–	–	–	·5*	·4	·5	·6	·8	1·3*	1·3*	–	–
X.	·2	·3	·3	·2	·6	·8	·7	1·0	·6	·3	·2	·3
XI.	·5	·4	·1	·1	·1	·2	·1	·3	–	–	·0*	·2*
XII.	–	·1	2	·1	·6*	·0*	·1	·1	1·5*	–	–	–
XIII.	·3	1·2	1·0	1·6	1·6	3·9	9·3*	3·5	·6	·2	·1	·5
XIV.	·6	·6	·8	1·0*	1·2	1·6	1·2	1·0	2·0	·4	·5	·6
XV.	·2	·3	·2	·2	·1	·3*	–	·0	·6*	·4	·6	·3
XVI.	·1	·1	·3	·2	–	–	–	–	–	–	1·0	·3
XVII.	2·1	2·5	1·2	1·9	11·5	8·1	5·6	3·6	3·1	2·6	2·0	3·0
XVIII.	·8	1·4	·8	2·4	4·4	1·6	·7	1·5	1·5	1·0	·6	·4
XIX.	·2	·2	·2	·2	·1	·2	·7	1·2	1·7	·1	·8	·2
XX.	·1	·2	·1	·1	–	–	–	–	3·0	–	·6	·4
XXIII.	3·9	4·5	3·3	5·7	7·1	5·9	6·6	5·7	3·8	4·2	2·6	2·1
XXIV.	·0*	–	1·4*	1·9	–	20·8	12·5	9·9	5·2	·9	2·2	·6
XXV.	–	·2*	–	–	5·9	–	2·2*	1·1*	2·4	1·5	2·6	·5
XXVI.	–	–	·1*	–	–	–	–	1·6	1·6	1·2	·8	·3
XXVIII.	2·3*	2·1	5·5	–	6·2*	6·6	5·3	7·7	3·5	2·9	2·4	2·4
XXIX.	3·1	6·4	4·9	7·5	11·7	12·8	11·0	12·0	7·9	8·2	3·9	3·7
XXX.	–	·2*	–	–	–	1·8*	–	4·0	1·2	2·1	1·3	–
XXXI.	–	–	–	–	–	–	2·6	·9	1·4	2·4	1·2	–
XXXII.	–	–	–	–	–	–	1·4	1·8	1·9	–	1·8	·8*
C.	·5	·4	·4	·4	·4	·5	1·1	·7	1·9	·2	·3	2·6
D.	1·9	1·2	2·4	3·1	–	1·0	·2	–	·5	·8	·7	1·6
J.	·0*	·4	·5*	–	·0*	·7	–	·4	–	–	·0*	·0*
K.	·2	·1	·3	·2	·9	–	·4	·3*	–	–	–	·0*
Var. N. Sea	·5	·9	·6	·9	1·5	1·9	2·2	2·3	2·0	1·1	1·0	·7
C.D. Minch	1·1	1·7	1·6	2·3	2·8	2·3	1·9	2·2	5·6	·6	·8	1·4
Western Grounds	·5	·7	·9	·7	·2	·5	·4	·4	·3	·4*	·0	·1
Faroe	9·1	6·9	9·3	9·8	8·3	11·1	7·8	7·2	5·8	3·1	2·5	3·3
Iceland	1·5	·4	·1	·8	1·6	2·2	2·2	1·1	·5	·3	·4	·2

Area VII., Apr. 0·0, May ·1*, Nov. 0·0*; VIII., Apr. 0·0, May 0·0, July ·2, Aug. ·2; XXII., Jan. 1·9*, Feb. 2·9, Dec. 1·3*; XXVII., July 2·2*, Aug. 1·5, Sept. 2·3; XXXIII., Aug. 1·6; XXXIV., Dec. 2·4*; XXXV., Aug. ·8*, Sept. ·4, Oct. ·6, Nov. 1·8; XXXVI., Sept. ·3*, Oct. 0·0*; XL., Sept. ·3; XLIII., Sept. ·3*; M., Feb. ·8*, May ·3, Aug. 1·1, Sept. 1·2*; L., July ·2*; S., June 0·0*, Nov. 0·0*; Minch, Jan. ·2, Mar. 1·5, Apr. 2·2, July ·6*; Rockall, June ·1*; Norway, Apr. ·4, May ·6, Nov. 0·0*; White Sea, Aug. 0·0, Sept. 0·0, Oct. 0·0, Dec. ·1*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Small Lemons,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·0	·0	·0	·0	·1	–	–	–	–	·0	·0	–
IX.	–	–	–	1·4*	·4	·5	1·2	1·0	1·3*	·0*	–	–
X.	·1	·2	·2	·1	·3	·9	·9	·9	·4	·1	·1	·0
XI.	·0	·0	·0	·0	·0	·0	·0	·1	–	–	·0*	·0*
XII.	–	·0	·0	·0	·0	·0*	·0	·2	·0*	–	–	–
XIII.	·3	·4	·3	1·8	·9	2·0	9·7*	3·0	·2	·1	·0	·3
XIV.	·3	·2	·3	·1*	·8	1·1	1·3	1·2	·3	·2	·5	·4
XV.	·0	·0	·0	·1	·0	·0*	–	·0	·7*	·0	·0	·0
XVI.	·0	·0	·0	·0	–	–	–	–	–	–	·6	·0
XVII.	1·1	1·5	·8	1·2	4·3	3·8	3·4	2·2	3·0	2·6	2·4	2·7
XVIII.	·2	·6	·2	1·1	1·9	·6	·2	·4	·4	·5	·3	·1
XIX.	·0	·0	·0	·0	·0	·1	·0	·4	·3	·0	·1	·0
XX.	·0	·0	·0	·0	–	–	–	–	·3	–	·1	·0
XXIII.	2·5	2·1	2·8	2·9	4·5	5·7	4·8	4·9	3·3	4·4	3·8	2·3
XXIV.	·0*	–	·3*	·4	–	2·5*	1·4	·7	·3	·1	·7	·0
XXV.	–	·0*	–	–	·3	–	·0	·0*	·1	·1	·2	·0
XXVI.	–	–	·0*	–	–	–	–	·1	·1	·0	·1	·0
XXVIII.	2·7*	1·9	4·6	–	5·9	8·8	5·1	8·1	4·5	3·0	4·8	3·5
XXIX.	2·2	2·1	1·6	2·9	3·8	8·7	6·6	5·3	4·5	4·1	4·0	2·5
XXX.	–	·0*	–	–	–	·0*	–	·3	·3	·5	·1	–
XXXI.	–	–	–	–	–	–	·0	·0	·2	·2	·1	–
XXXII.	–	–	–	–	–	–	·0	·1	·2	–	·1	·8*
C.	·4	·1	·1	·1	·2	·4	·8	·5	2·7	·1	·2	1·8
D.	1·9	·8	1·1	2·0	–	·7	·6	–	1·3	1·7	1·2	1·3
J.	·0*	·0	1·6*	–	·0	·5	–	·0	–	–	·0*	·0*
K.	·4	·0	·1	·0	·5	–	·4	·0*	–	–	–	·0*
Var. N. Sea.	·3	·3	·2	·4	·7	1·1	1·5	1·4	·6	·4	·4	·4
C.D. Minch	·7	·7	·8	1·6	1·4	1·1	1·7	1·6	4·1	·4	·5	·9
Western Grounds	·3	·3	·6	·3	·0	·1	·3	·4	·0	·0*	·0	·0
Faroe.	1·8	1·4	2·2	2·4	3·1	3·0	2·6	2·3	2·4	1·2	1·2	·9

No Small Lemons recorded from Areas VII., VIII., XXXVI., XL., XLIII., S., Rockall, Iceland, White Sea.

Area XXII., Jan. 1·6*, Feb. 1·8, Dec. 2·4*; XXVII., July 2·3*, Aug. ·1, Sept. 0·0; XXXIII., Aug., ·1; XXXIV., Dec. 0·0*; XXXV., Aug. 0·0*, Sept. 0·0, Oct. ·1, Nov. 1·0; XXXVI., Sept. 0·0*, Oct. 0·0; XL., Sept. 0·0; XLIII., Sept. 0·0*; M., Feb. 0·0*, May 0·0, Aug. ·5, Sept. ·9*; L., July 1·8*; S., June 0·0*, Nov. 0·0*; Minch, Jan. 0·0, Mar. 1·3, Apr. 1·3, July 0·0*; Norway, Apr. 0·0, May ·1, Nov. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Large Plaice,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
XI.	·6	·2	·0	·0	·0	·0	·0	·0	–	–	·0*	·0*
XIII.	·0	·3	·4	·5	·1	·1	·0*	·0	·0	·0	·3	·1
XIV.	·1	·0	·4	·0*	·1	·0	·1	·0	·0	·0	·0	·0
XV.	·0	·0	·0	·0	·0	·0*	–	·0	·0*	·2	·0	·0
XVI.	·0	·0	·1	·0	–	–	–	–	–	–	·0	·0
XVII.	·4	·1	·3	·1	·1	·1	·0	·1	·0	·1	·0	·2
XVIII.	·1	·0	·0	·1	·1	·0	·0	·0	·0	·0	·0	·0
XX.	·0	·0	·1	·0	–	–	–	–	·4	–	·2	·0
XXIII.	·1	·1	·3	·1	·1	·1	·0	·0	·0	·0	·0	·0
XXV.	–	·5*	–	–	·6	–	·0*	·7*	·4	·3	·2	·0
XXVI.	–	–	·0*	–	–	–	–	·7	·7	·8	·7	·1
XXVIII.	·2*	·0	·4	–	·0*	·6	·2	·3	·0	·1	·3	·0
XXIX.	·0	·9	·2	·2	·3	·1	·1	·0	·2	·1	·0	·1
XXX.	–	·0*	–	–	–	·0*	–	·7	·4	·0	·0	–
XXXI.	–	–	–	–	–	–	·3	·0	·4	·1	·1	–
XXXII.	–	–	–	–	–	–	·3	·6	·7	–	2·5	·0*
C.	·0	·1	·4	·1	·1	·1	·0	·0	·2	·6	·1	·4
D.	1·0	·8	1·5	·4	–	1·7	·0	–	·0	·2	·0	·6
J.	·0*	·0	1·9*	–	·0*	·0	–	·0	–	–	·0*	·0*
K.	·1	·6	·2	·0	·0	–	·0	·0*	–	–	–	·0*
Var. N. Sea.	·1	·0	·1	·1	·1	·0	·0	·0	·2	·1	·1	·0
C.D. Minch.	·3	·7	·7	·7	·5	·2	·5	·0	·0	·1	·0	·2
Western Grounds.	·4	·8	·2	·4	·0	·0	·2	·0	·0	·0*	·4	·0
Faroe.	·5	·8	1·1	·5	·2	·1	·0	·0	·1	·1	·0	·4
Iceland	2·0	·6	·4	·9	·1	·0	·0	·0	·1	·0	·1	·1

No Large Plaice recorded from Areas VI.–X., XII., XIX., XXII., XXIV., XXXVI., XL., L., S., Rockall.

Area XXVII., July ·5*, Aug. ·4, Sept. 1·5; XXXIII., Aug. ·9; XXXIV., Dec. ·5*; XXXV., Aug. 0·0*, Sept. 0·0, Oct. ·1, Nov. 0·0; XLIII., Sept. 2·7*; M., Feb. 0·0*, May 0·0, Aug. ·2, Sept. 1·8*; Minch, Jan. 0·0, Mar. 4·0, Apr. 1·0, July 0·0*; Norway, Apr. 0·0, May ·2, Nov. 0·0*; White Sea, Aug. 0·0, Sept. ·1, Oct. ·8, Dec. 1·4*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Medium Plaice,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·2	·0	·5	·0	·1	–	–	–	–	·1	·0	–
IX.	–	–	–	·5*	·4	1·6	·2	·6	·0*	2·5*	–	–
X.	·3	·3	·9	·3	1·0	1·1	·6	·5	·4	·2	·1	·2
XI.	·6	·2	·0	·1	·0	·0	·0	·4	–	-	·0*	·0*
XII.	–	·1	·3	·1	·0*	·0*	·0	·1	·0*	–	–	–
XIII.	·4	2·3	5·3	4·4	2·8	2·1	33·3	3·7	·3	·6	2·0	1·0
XIV.	·4	·3	2·5	·0*	2·5	1·2	1·3	1·0	·7	·1	·1	·2
XV.	·0	·1	·1	·4	·0	·0*	–	·0	·4	·1	·0	·1
XVI.	·0	·2	·2	·1	–	–	–	–	–	–	·6	·2
XVII.	3·8	2·0	4·4	1·7	4·3	3·9	2·0	3·7	5·5	3·7	2·7	5·7
XVIII.	·7	·7	·6	1·3	1·7	·3	·1	·1	·2	·3	·1	·1
XIX.	·0	·1	·0	·0	·0	·0	·1	·2	·2	·1	·1	·1
XX.	·0	·1	·0	·0	–	–	–	–	3·3	–	1·1	·3
XXIII.	3·5	4·6	6·7	2·5	2·4	2·4	1·5	1·1	1·1	1·5	1·9	2·2
XXIV.	·0*	–	·5*	·3	–	4·4*	2·9	1·4	·4	·1	·8	·0
XXV.	–	2·8*	–	–	10·1	–	9·7	5·4*	2·8	3·0	1·5	·4
XXVI.	–	–	·1*	–	–	–	–	2·6	3·1	4·6	2·1	·4
XXVIII.	2·7*	2·6	4·9	–	9·3*	5·0	6·1	4·2	7·2	6·3	3·9	3·6
XXIX.	2·7	11·8	10·4	4·2	1·6	2·3	2·0	2·1	2·6	3·2	1·0	2·0
XXX.	–	·0*	–	–	–	1·1*	–	2·6	2·8	·5	·2	–
XXXI.	–	–	–	–	–	–	2·4	1·0	2·5	1·6	1·9	–
XXXII.	–	–	–	–	–	–	1·8	3·3	3·1		8·7	·8*
C.	·7	1·1	1·4	·8	2·7	2·1	2·5	1·4	5·3	3·4	·5	8·2
D.	5·0	3·8	14·3	6·4	–	7·9	5·0	–	8·2	7·5	1·6	6·8
J.	·0*	·9	7·2*	–	8·8*	2·6	–	2·0	–	–	·0*	·3*
K.	1·5	2·1	1·0	·0	1·2	–	1·0	·1*	–	–	–	·0*
Var. N. Sea	·8	·6	1·1	·9	1·4	1·4	1·1	1·1	1·8	·7	1·3	6
C.D. Minch	3·7	3·3	6·5	6·2	5·6	4·3	5·7	3·9	2·9	2·8	3·6	2·6
Western Grounds	1·6	1·6	2·0	5·5	4·8	2·3	12·3	3·5	2·0	1·3*	9·6	·3
Faroe.	1·0	1·3	1·6	·8	1·1	·3	·2	·3	·4	·3	·0	·4
Iceland	4·8	1·9	1·5	3·1	2·0	1·0	·9	1·1	1·4	3·6	4·1	3·9

No Medium Plaice recorded from Areas VII., VIII., XXXVI., S., Rockall.

Area XXII., Jan. 1·4*, Feb. 1·2, Dec. 1·6*; XXVII., July ·9*, Aug. 2·7, Sept. 9·5; XXXIII., Aug. 5·1; XXXIV., Dec. 3·8*; XXXV, Aug. ·4*, Sept. ·1, Oct. ·4, Nov. ·8; XL., Sept. ·4; XLIII., Sept. 132·6*; M., Feb. 14·3*, May 0·0, Aug. 24·8, Sept. 24·4*; L., July ·7*; Minch, Jan. ·1, Mar. 50·0, Apr. 23·9, July ·2*; Norway, Apr. 4·7, May 3·6, Nov. 1·7*; White Sea, Aug. 3·3, Sept. 10·9, Oct. 18·6, Dec. 28·4*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Small Plaice**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
IX.	–	–	–	·0*	·0	·0	·0	·0	·0*	3·3*	–	–
X.	·2	·0	·4	·0	·2	·0	·0	·0	·0	·0	·0	·1
XIII.	·2	·4	1·6	·9	·4	·1	4·7*	·9	·0	·1	1·1	·0
XIV.	·0	·0	·6	·0*	·1	·0	·1	·0	·0	·0	·0	·0
XVII.	·3	·2	·7	·3	·6	·2	·3	·6	·2	·1	·1	·4
XVIII.	·0	·0	·1	·1	·0	·1	·0	·0	·0	·0	·0	·0
XX.	·0	·0	·0	·0	–	–	–	–	·3	–	·0	·0
XXIII.	2·3	1·0	2·7	·4	·4	·8	·5	·3	·8	·6	1·6	1·3
XXV.	–	1·6*	–	–	·0	–	·0*	1·1*	·1	·1	·0	·0
XXVI.	–	–	·0*	–	–	–	–	·1	·2	·1	·0	·0
XXVIII.	1·1*	·6	1·9	–	11·2*	12·0	7·4	7·0	29·7	22·4	5·6	3·4
XXIX.	·3	1·6	·7	·7	·1	·1	·1	·1	·1	·4	·2	·5
XXX.	–	·0*	–	–	–	·0*	–	·0	·2	·0	·0	–
XXXI.	–	–	–	–	–	–	·0	·0	·1	·0	·0	–
XXXII.	–	–	–	–	–	–	·4	·2	·2	–	·2	·0*
C.	·0	·0	·2	·2	·5	·2	·0	·0	·0	·1	·0	·2
D.	·2	1·5	5·5	·7	–	3·1	·0	–	2·5	·4	·1	·9*
J.	·0*	·0	19·5	–	·0*	·0	–	·0	–	–	·0*	·0*
K.	·0	1·1	·0	·0	·0	–	·2	·0*	–	–	–	·0
Var. N. Sea	·0	·2	·2	·2	·2	·5	·2	·2	·5	·0	·1	·1
C.D. Minch	·4	·7	1·4	1·2	1·3	·7	6·9	1·7	1·1	·1	3·3	·3
Western Grounds	·0	·2	1·4	·4	2·0	·2	2·4	·6	·7	·0*	3·8	·0
Faroe	·0	·1	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0
Iceland	2·2	·0	·1	·1	·0	·0	·0	·1	·1	1·4	·6	·2

No Small Plaice recorded from Areas VI., VII., VIII., XI., XII., XV., XVI., XIX., XXIV., XXXIV., XXXV., XXXVI., XL., L., S., Rockall, Norway.

Areas XXII., Jan. 0·0*, Feb. ·3, Dec. ·8*; XXVII., July ·1*, Aug. ·2, Sept. 2·2; XXXIII., Aug. ·3; XLIII., Sept. 170·0*; M., Feb. 4·0*, May 0·0, Aug. 18·8, Sept. 28·0*; Minch, Jan. 0·0, Mar. 10·7, Apr. 10·9, July 0·0*; White Sea, Aug. 0·0, Sept. 1·6, Oct. 3·6, Dec. 1·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Dabs**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
IX.	–	–	–	·0*	·0	·0	·0	·0	·0*	·8*	–	–
X.	·0	·0	·0	·0	·0	·0	·0	·1	·0	·0	·0	·0
XI.	·0	·2	·0	·0	·0	·0	·0	·0	–	–	·0*	·0*
XIII.	·1	·1	·1	·0	·0	·0	1·7*	·4	·0	·1	·6	·0
XVII.	·1	·6	·1	·2	·4	·0	·2	·3	·0	·0	·0	·5
XVIII.	·0	·2	·0	·2	·0	·0	·0	·0	·0	·0	·0	·0
XXIII.	·9	·5	·8	·4	·4	·3	·2	·2	·7	·8	1·5	1·5
XXIV.	·0*	–	·0*	·4	–	·0*	·0	·0	·0	·0	·1	·0
XXV.	–	5·5	–	–	·0	–	·0	·7*	·0	·0	·0	·0
XXVI.	–	–	·0*	–	–	–	–	·0	·0	·0	·0	·0
XXVIII.	·0*	·0	2·3	–	3·9*	2·9	2·0	2·4	6·5	7·5	2·6	2·4
XXIX.	·7	·7	·6	·9	·1	·8	·3	·1	·2	·8	·7	·9
XXX.	–	·0*	–	–	–	·0*	–	·0	·0	·0	·0	–
XXXI.	–	–	–	–	–	–	·0	·0	·1	·0	·0	–
XXXII.	–	–	–	–	–	–	·0	·0	·0	–	·0	·0*
C.	·0	·0	·0	·0	·0	·0	·0	·0	·4	·1	·0	·2
D.	·6	·0	·0	·0	–	·4	·0	–	·0	·0	·0	·8
Var. N. Sea	·1	·1	·0	·1	·1	·0	·1	·1	·1	·0	·1	·0
C.D. Minch	·4	·2	·1	·2	·3	·2	·4	·5	·4	·3	·7	·1
Western Grounds	·2	·0	·0	·0	·0	·0	·8	·0	·0	·0*	·6	·0
Faroe	·7	·9	·5	·1	·6	·2	·2	1·0	·5	·3	·9	·3
Iceland	·0	·0	·3	·0	·0	·0	·0	·0	·0	·0	·0	·0

No Dabs recorded from Areas VI., VII., VIII., XII., XIV., XV., XVI., XIX., XX., XXVII., XXXIII., XXXIV., XXXV., XXXVI., XL., J., K., L., S., Rockall, Norway, White Sea.

Area XXII., Jan. 1·4*, Feb. ·1, Dec. 0·0*; XLIII., Sept. 8·3*; M., Feb. 0·0*, May 0·0, Aug. 2·9, Sept. ·6*; Minch, Jan. 0·0, Mar. ·2, Apr. ·1, July 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Large Witches**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913).

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·5	·3	·2	·0	·0	–	–	–	–	·4	·2	–
IX.	–	–	–	·0*	·0	·0	·0	·1	·2*	1·3*	–	–
X.	·3	·3	·1	·1	·1	·2	·0	·1	·1	·8	1·0	1·9
XI.	1·5	1·3	·9	·5	·3	·3	·0	·0	–	–	·6*	1·8*
XII.	–	·6	·8	·8	3·3*	·0*	·2	·2	2·9*	–	–	–
XIII.	·7	·6	·2	·3	·0	·1	·5*	·1	2·8	1·6	1·3	·3
XIV.	1·0	1·3	1·2	5·9*	·4	·1	·3	·9	1·5	1·3	1·8	·9
XV.	2·6	2·1	1·8	1·9	8·6	8·1*	–	3·3	1·8*	1·7	4·7	3·1
XVI.	2·0	·5	·8	·5	–	–	–	–	–	–	1·6	1·3
XVII.	1·5	1·6	·5	·5	·2	·2	·3	·1	·8	·7	·5	·4
XVIII.	3·6	3·3	1·7	1·2	2·2	4·2	4·5	3·5	2·8	2·5	2·9	2·7
XIX.	3·0	2·7	1·9	3·9	13·4	13·3	5·4	2·1	2·2	3·0	2·4	2·4
XX.	·6	1·6	·6	1·1	–	–	–	–	1·0	–	1·0	1·6
XXIII.	1·3	1·0	·6	·9	·8	·6	·7	·7	1·5	1·0	·8	·4
XXIV.	·0*	–	1·6*	2·2	–	·6*	1·1	1·4	2·3	2·6	1·9	4·4
XXV.	–	·5*	–	–	1·4	–	·3*	·7*	·3	·8	1·2	1·4
XXVI.	–	–	1·1*	–	–	–	–	·1	·3	·2	·2	·2
XXVIII.	·2*	·2	·8	–	1·5*	·8	·0	·0	·0	·1	·3	·1
XXIX.	·5	·1	·1	·0	·1	·1	·1	·1	·1	·1	·1	·1
XXX.	–	5·8*	–	–	–	4·5*	–	1·1	·7	1·7	2·1	–
XXXI.	–	–	–	–	–	–	·5	·1	·6	1·2	·6	–
XXXII.	–	–	–	–	–	–	·1	·2	·3	–	·1	2·8
C.	·0	·2	·1	·0	·0	·1	·0	·0	·1	·0	·1	·3
D.	·0	·3	·1	·2	–	·0	·0	–	·3	·0	·3	·1
J.	·0*	·4	·0*	–	·0*	·1	–	·0	–	–	·0*	·0*
K.	·2	·0	·2	·0	·6	–	·0	·0	–	–	–	·0*
Var. N. Sea	1·7	1·9	·9	·5	·8	1·2	·9	·9	1·0	1·2	1·3	1·4
C.D. Minch	·1	·6	·2	·1	·0	1·1	·2	·0	·1	1·1	·4	·4
Western Grounds	·3	2·8	·5	·0	·0	·1	·0	·0	·5	·0*	·1	·3
Faroe	·0	·0	·0	·0	·0	·0	·0	·0	·1	·0	·0	·0*
Iceland	1·2	·9	·6	3·4	3·5	3·8	3·3	1·8	2·8	2·4	1·1	1·2

Area VII., Apr. ·2, May ·1*, Nov. 1·9* ; VIII., Apr. 0·0, May 0·0, July ·1, Aug. 0·0 ; XXII., Jan. 2·6*, Feb. 2·5, Dec. ·8* ; XXVII., July 0·0*, Aug. ·1, Sept. 0·0 ; XXXIII., Aug. ·6 ; XXXIV., Dec. 0·0* ; XXXV., Aug. ·5*, Sept. ·1, Oct. ·3, Nov. ·2 ; XXXVI., Sept. ·3, Oct. 0·0* ; XL., Sept. 0·0 ; XLIII., Sept. 0·0* ; M., Feb. ·5*, May 17·0, Aug. ·5, Sept. 0·0* ; L., July 0·0* ; S., June 0·0*, Nov. 0·0* ; Minch, Jan. 21·5, Mar. 0·0, Apr. ·1, July 2·7* ; Rockall, June 0·0* ; Norway, Apr. 0·0, May ·3, Nov. 0·0* ; White Sea, Aug. ·7, Sept. 0·0, Oct. 0·0, Dec. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Small Witches,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·2	·0	·0	·0	·0	–	–	–	–	·8	·1	–
IX.	–	–	–	·0*	·0	·0	·0	·1	·0*	1·7*	–	–
X.	·3	·5	·2	·1	·0	·5	·1	·0	·6	3·1	3·4	6·5
XI.	3·5	2·8	1·2	1·0	·5	·9	·0	·0	–	–	·0*	·0*
XII.	–	·9	·7	1·3	10·7*	·0*	·1	·2	7·3*	–	–	–
XIII.	·0	·4	·2	·1	·0	·2	·0*	·0	8·6	4·9	2·4	·4
XIV.	2·6	2·9	2·7	14·9*	·9	·2	·9	2·1	5·1	4·8	6·9	3·7
XV.	6·9	4·7	3·7	4·6	28·1	25·9*	–	18·7	4·2*	4·0	3·5	10·6
XVI.	3·2	·8	1·3	·7	–	–	–	–	–	–	3·5	1·3
XVII.	2·1	4·0	1·1	·7	·1	·1	·6	·1	1·8	1·0	·7	·7
XVIII.	11·6	9·3	5·3	3·2	2·8	13·6	9·8	8·8	8·8	7·0	9·1	9·8
XIX.	8·5	7·0	3·4	8·5	33·6	34·7	13·6	3·8	5·9	10·0	5·6	8·4
XX.	1·2	2·4	·6	2·8	–	–	–	–	·8	–	1·0	1·5
XXIII.	1·9	1·6	·7	·6	·9	·7	1·6	1·7	3·7	1·7	1·6	·7
XXIV.	·0*	–	2·0*	4·7	–	·0*	2·2	3·2	6·2	4·6	2·6	7·1
XXV.	–	·0*	–	–	1·7	–	·0*	·0*	·1	1·3	·6	2·1
XXVI.	–	–	1·7*	–	–	–	–	·0	·1	·0	·0	·2
XXVIII.	·0*	·0	·1	–	·0*	·1	·0	·0	·0	·0	·0	·0
XXIX.	·0	·0	·0	·0	·0	·0	·1	·0	·0	·0	·0	·0
XXX.	–	9·2*	–	–	–	·7*	–	·2	·3	·5	·5	–
XXXI.	–	–	–	–	–	–	·3	·0	·4	·1	·1	–
XXXII.	–	–	–	–	–	–	·0	·0	·0	–	·0	·5*
C.	·0	·0	·1	·0	·0	·0	·1	·0	·2	·0	·2	·0
D.	·0	·4	·0	·0	–	·0	·0	–	·0	·0	·8	·0
Var. N. Sea	3·1	4·9	1·8	·7	1·4	2·9	2·2	2·1	2·1	2·8	2·4	3·7
C.D. Minch	·7	1·3	·2	·1	·0	1·4	·0	·0	·0	2·3	·9	1·4
Western Grounds	·8	6·1	·0	·0	·0	·0	·0	·0	3·1	·0*	4·6	3·9
Faroe	·0	·0	·0	·0	·0	·1	·0	·0	·0	·0	·0	·0
Iceland	·0	·2	·0	·0	·1	·0	·2	·3	·1	1	·3	·6

No Small Witches recorded from Areas VII., XXVII., XXXIII., XXXIV., XXXVI., XL., XLIII., J., K., L., S., Rockall, Norway, White Sea.

Area VIII., Apr. 0·0, May 0·0, July ·2, Aug. 0·0 ; XXII., Jan. 7·7*, Feb. 6·6, Dec. 1·7* ; XXXV., Aug. 0·0*, Sept. 0·0, Oct. ·1, Nov. 0·0 ; M., Feb. 0·0*, May 26·3, Aug. 1·8, Sept. 0·0* ; L., July 0·0* ; S., June 0·0*, Nov. 0·0* ; Minch, Jan. 60·2, Mar. 0·0, Apr. ·2, July 6·2*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Large Megrims,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	10·1	7·6	5·0	10·3	6·1	–	–	–	–	6·9	13·1	–
IX.	–	–	–	·5*	·9	·4	·4	1·1	·6*	2·5*	–	–
X.	6·3	2·9	2·7	2·8	1·8	·7	·5	·8	3·7	6·0	9·5	4·0
XI.	1·2	·7	·6	1·1	4·3	2·6	3·3	4·0	–	–	18·6*	6·2*
XII.	–	1·9	1·6	1·1	4·2*	2·7*	2·4	5·0	5·4*	–	–	–
XIII.	7·3	3·2	1·7	·7	1·1	1·0	5·0*	1·6	14·7	10·1	10·4	2·7
XIV.	1·4	1·6	2·0	1·2*	1·5	·8	1·2	1·6	2·2	1·1	1·2	1·2
XV.	·8	·8	·8	2·6	·7	1·6*	–	·0	1·4*	·7	·2	·6
XVI.	·8	·4	·9	·6	–	–	–	–	–	–	·0	·4
XVII.	·9	1·1	1·0	·7	·4	·2	·4	·3	·5	·4	·4	1·1
XVIII.	2·4	5·1	4·7	1·3	1·7	3·8	3·1	4·2	4·2	2·3	2·2	1·0
XIX.	·6	·7	·5	6	1·6	1·2	1·9	2·3	1·4	·6	·4	·4
XX.	·4	·2	·2	·3	–	–	–	–	·2	–	·0	·1
XXIII.	·9	·9	·5	·6	·6	·9	·7	·9	1·4	·9	·9	·6
XXIV.	·0*	–	1·4*	1·1	–	·0*	·3	·4	1·4	·7	·1	·4
XXV.	–	·0*	–	–	·2	–	·0*	·0*	·1	·1	·0	·0
XXVI.	–	–	·0*	–	–	–	–	·0	·0	0	·0	·2
XXVIII.	·0*	·1	·2	–	·0*	1·2	·0	·1	·2	·1	·9	·4
XXIX.	·9	·3	·1	·0	1·4	·8	·8	·2	·5	·6	1·3	1·0
XXX.	–	·2*	–	–	–	·0*	–	·0*	·0	·1	·0	–
XXXI.	–	–	–	–	–	–	·2	·0	·1	·0	·1	–
XXXII.	–	–	–	–	–	–	·2	·0	·0	–	·0	·2*
C.	·5	1·0	·5	·7	·4	·5	·5	·7	·5	2·1	2·8	1·0
D.	·7	·2	·2	·4	–	·4	·0	–	·3	·0	·5	·7
J.	1·7*	·0	·5*	–	1·0*	·4	–	·3	–	–	·8*	·0*
K.	2·4	·8	·5	·6	1·2	-	1·1	·8*	–	–	–	·0*
Var. N. Sea	2·0	2·0	1·9	3·7	1·6	·9	1·1	1·6	1·3	1·7	1·8	2·2
C.D. Minch	1·9	2·2	1·1	·7	·5	·8	·4	·4	·7	7·3	4·3	1·6
Western Grounds	1·9	2·5	·5	·6	·5	·4	1·1	·6	1·6	1·2*	1·8	1·2
Faroe	·0	·0	·0	·0	·4	·0	·0	·1	·2	·2	·2	·0
Iceland	·2	·1	·0	·1	·8	·1	1·5	1·2	1·0	2·2	·3	·7

No Large Megrims recorded from Areas XXXIII., XXXIV., XXXV., XXXVI., XL., XLIII., L. Area VII., Apr. 3·9, May 5·0*, Nov. 34·6*; VIII., Apr. 1·3, May 3·1, July 2·4, Aug. 10·3; XXII., Jan. 1·9*, Feb. 1·2, Dec. 1·3*; XXVII., July ·3*, Aug. 0·0, Sept. 0·0; M., Feb. 0·0*, May 1·3, Aug. 1·5, Sept. 0·0*; S., June 1·3*, Nov. ·3*; Minch, Jan. 3·7, Mar. ·3, Apr. ·3, July 6·2*; Rockall, June 17·1*; Norway, Apr. ·4, May 2·5, Nov. 0·0*; White Sea, Aug. 0·0, Sept. ·9, Oct. 1·3, Dec. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Small Megrims,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	3·2	3·5	4·8	6·6	2·7	–	–	–	–	4·2	7·3	–
IX.	–	–	–	·0*	1·8	·3	·5	·9	·0*	1·3*	–	–
X.	2·1	2·1	2·4	1·9	1·4	·2	·2	·4	1·5	7·5	6·7	6·1
XI.	·5	·1	·1	·5	2·2	·5	1·5	·9	–	–	4·7*	5·6*
XII.	–	·8	·8	·6	·6*	1·0*	1·4	1·4	1·5*	–	–	–
XIII.	6·3	1·8	·5	1·2	·4	·1	·8*	·0	2·2	4·8	8·5	2·0
XIV.	·5	·9	1·7	·6*	·6	·3	·2	·9	1·2	·8	·8	·8
XV.	·2	·3	·2	1·2	·3	·0*	–	·0	·0*	·3	·0	·1
XVI.	·5	·3	·6	·3	–	–	–	–	–	–	·0	·2
XVII.	·1	·3	·3	·2	·1	·0	·2	·1	·0	·0	·0	·2
XVIII.	·9	2·5	2·9	·7	·9	1·2	1·2	1·2	1·7	1·1	·9	·3
XIX.	·2	·2	·0	·7	·5	·6	·1	·1	·4	·1	·2	·1
XX.	·0	·0	·4	·0	–	–	–	–	·0	–	·0	·0
XXIII.	·1	·1	·1	·0	·1	·2	·2	·2	·2	·1	·1	·0
XXIV.	·0*	–	·9*	·0	–	·0*	·2	·0	·1	·2	·0	·0
XXVI.	–	–	·0*	–	–	–	–	0	·0	·0	·0	·2
XXVIII.	·0*	·0	·0	–	·0*	·4	·0	·0	·0	·0	·1	·0
XXIX.	·1	·0	·0	·0	·2	·0	·2	·0	·0	·0	·0	·0
C.	·1	·4	·2	·5	·3	·2	·1	·2	·4	1·2	2·0	·0
D.	·1	·0	·0	·0	–	·1	·0	–	·0	·0	·0	·1
J.	·0*	·0	·0*	–	·0*	·3	–	·0	–	–	·0*	·0*
K.	·4	·4	·2	·4	1·5	–	·4	·8	–	–	–	·0*
Var. N. Sea	·7	·9	1·1	2·6	·9	·4	·4	·5	·6	1·1	1·5	2·1
C.D. Minch	1·0	1·0	·4	·2	·3	·3	·2	·3	·0	4·3	2·4	·7
Western Grounds	·9	1·9	·7	·3	·2	·5	·7	·3	·3	·0*	·9	·3
Faroe	·0	·0	·0	·0	·1	·0	·0	·0	·1	·0	·1	·0
Iceland	·0	·0	·0	·0	·0	·0	·0	·0	·0	·1	·1	·0

No Small Megrims recorded from Areas XXV., XXVII., XXX., XXXI., XXXII.–XLIII., L., White Sea.

Area VII., Apr. 3·3, May 2·0*, Nov. 13·3*; VIII., Apr. ·9, May ·9, July ·8, Aug. 2·1; XXII., Jan. 0·0*, Feb. ·1, Dec. ·8*; M., Feb. 0·0*, May 0·0, Aug. 1·8, Sept. 0·0*; S., June 1·3*, Nov. ·3*; Minch, Jan. ·4, Mar. 0·0, Apr. ·4, July 2·7*; Rockall, June 7·0*; Norway, Apr. ·7, May 1·1, Nov. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Eels,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
IX.	–	–	–	·0*	·0	·0	·0	·1	·0*	·0*	–	–
X.	·0	·1	·0	·0	·0	·0	·0	·0	·1	·1	·0	·0
XIII.	·3	·1	·1	·1	·1	·1	2·3*	·1	·1	–	1·0	·4
XIV.	·0	·0	·0	·0*	·0	·0	·1	·1	·0	·4	·0	·1
XVI.	·0	·0	·0	·0	–	–	–	–	–	·0	·1	·0
XVII.	·4	·3	·1	·0	·1	·3	·5	·3	·3	·6	·6	·4
XVIII.	·1	·1	·1	·0	·1	·0	·0	·0	·0	·0	·0	·0
XXIII.	·1	·1	·1	·0	·0	·0	·0	·0	·0	·1	·1	·1
XXVI.	–	–	·0*	–	–	–	–	·0	·0	·0	·1	·0
XXVIII.	·0*	·1	·2	–	·0*	·0	·0	·1	·0	·3	·1	·1
XXIX.	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0	·1
C.	·4	·1	·3	·0	·0	·0	·1	·1	1·7	·9	·3	1·9
D.	·4	·3	1·2	·6	–	·1	·2	–	·7	1·7	·7	2·5
J.	·0*	·9	·0*	–	·0*	·2	–	·3	–	–	·0*	·8*
K.	5·3	1·4	·9	·0	·5	–	·0	·0*	–	–	–	·0*
Var. N. Sea	·0	·1	·0	·0	·0	·0	·1	·1	·0	·1	·1	·1
C.D. Minch	·4	·4	·4	·1	·1	·9	·3	·4	·7	·5	·4	·8
Western Grounds	·0	1·8	1·0	·2	·0	·0	·3	·4	1·4	·0*	2·1	5·0

No Eels recorded from Areas VI., VII., VIII., XI., XII., XV., XIX., XX., XXIV., XXV., XXVII., XXX.–XLIII., Rockall, Faroe, Iceland, Norway, White Sea.

Area XXII., Jan. 0·0*, Feb. ·2, Dec. 0·0*; M., Feb. ·5*, May 16·0, Aug. 2·3, Sept. 0·0*; L., July ·6*; S., June ·8*, Nov. 24·4*; Minch, Jan. 26·0, Mar. 0·0, Apr. ·6, July 4·2*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Skate**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	20·5	28·2	22·7	15·4	4·3	–	–	–	–	18·7	30·0	–
IX.	–	–	–	9·5*	7·7	3·5	9·2	25·2	28·6*	43·3*	–	–
X.	23·6	16·7	14·1	13·2	5·0	7·9	10·0	14·3	10·1	32·8	20·9	16·3
XI.	9·8	4·0	4·2	3·6	6·4	8·6	8·1	4·1	–	–	19·8	13·3*
XII.	–	5·2	5·1	7·1	3·6*	14·6*	9·5	5·6	19·2*	–	–	–
XIII.	14·4	19·6	8·7	4·7	9·3	22·9	125·9*	26·1	35·0	12·8	22·4	16·6
XIV.	10·6	7·3	16·2	8·3*	6·3	9·0	12·7	16·6	11·6	4·0	6·6	10·0
XV.	3·1	3·2	3·5	3·7	2·3	4·3	–	5·0	6·9*	10·2	12·9	5·5
XVI.	2·6	2·3	3·4	2·8	–	–	–	–	–	–	7·0	5·0
XVII.	16·6	8·7	5·6	4·2	7·9	7·1	11·2	8·6	11·9	11·5	6·6	9·9
XVIII.	6·1	8·4	8·9	5·2	7·7	8·9	3·7	6·0	8·9	6·1	7·3	5·7
XIX.	2·2	3·2	3·8	1·9	4·8	3·2	3·0	2·6	3·9	5·8	4·3	3·1
XX.	2·1	2·0	3·0	1·3	–	–	–	–	2·0	–	3·0	2·4
XXIII.	12·3	9·8	11·6	7·1	8·2	7·3	9·4	12·1	9·6	10·0	8·5	9·0
XXIV.	·0*	–	13·0*	–	–	36·5*	16·8	9·9	8·6	4·3	7·7	5·6
XXV.	–	4·8*	–	3·6	6·2	–	1·4*	1·1*	1·7	1·6	3·5	1·4
XXVI.	–	–	·7*	–	–	–	–	1·1	1·7	·7	1·3	3·1
XXVIII.	8·9*	13·3	18·1	–	13·5*	13·2	4·2	11·8	8·6	6·5	7·8	10·2
XXIX.	7·3	8·7	8·2	7·7	6·9	9·8	7·8	12·1	11·0	8·4	9·4	8·4
XXX.	–	2·5*	–	–	–	2·3*	–*	1·1	2·7	3·1	3·1	–
XXXI.	–	–	–	–	–	–	·7	·5	1·8	2·5	1·7	–
XXXII.	–	–	–	–	–	–	·3	·9	1·3	–	·8	3·1*
C.	9·7	15·5	9·1	10·5	7·7	7·6	8·9	9·2	30·6	28·1	29·4	55·1
D.	17·6	45·7	14·1	8·8	–	17·1	22·1	–	59·3	46·7	33·1	45·7
J.	22·2*	9·7	73·7*	–	7·9*	6·6	–	9·7	–	–	66·7*	33·3*
K.	56·9	30·6	16·5	5·8	14·9	–	16·0	·0*	–	–	–	16·7*
Var. N. Sea	9·6	8·5	7·7	9·1	7·0	7·3	10·0	12·3	8·0	7·7	7·8	9·6
C.D. Minch	11·6	13·3	11·0	9·3	11·4	19·1	26·4	21·4	42·4	22·2	17·3	22·3
Western Grounds	8·2	20·3	11·3	12·1	5·7	3·6	40·2	21·7	30·3	22·6	175·7	78·3
Faroe	·4	·9	·8	·4	1·4	·6	1·3	1·8	1·9	2·8	3·4	1·5
Iceland	11·8	4·3	1·7	·6	3·2	1·6	2·9	4·4	4·9	4·0	2·9	3·7

Area VII., Apr. 16·0, May 4·0*, Nov. 36·2*; VIII., Apr. ·6, May 5·3, July 4·7, Aug. 10·1; XXII., Jan. 20·3*, Feb. 10·7, Dec. 3·2*; XXVII., July 2·2*, Aug. ·3, Sept. 6·0; XXXIII., Aug. 2·9; XXXIV., Dec. 4·8*; XXXV., Aug. 0·0*, Sept. 1·3, Oct. 1·0, Nov. ·5; XXXVI., Sept. 1·1*, Oct. 0·0*; XL., Sept. 0·0; XLIII., Sept. 0·0*; M., Feb. 269·8*, May 18·7, Aug. 71·9, Sept. 301·1*; L., July 7·4*; S., June 8·3*, Nov. 37·8*; Minch, Jan. 53·7, Mar. 7·0, Apr. 29·7, July 10·4*; Rockall, June 12·8*; Norway, Apr. 14·3, May 6·4, Nov. 0·0*; White Sea, Aug. ·4, Sept. 0·0, Oct. 0·0, Dec. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Gurnards,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	5·7	1·1	·0	·2	·2	–	–	–	–	·0	1·0	–
IX.	–	–	–	·0*	·0	·0	·0	1·8	·0*	·0*	–	–
X.	·1	·0	·0	·3	·1	·0	·0	·3	·0	1·1	·2	·0
XI.	·0	·0	·1	·0	·6	·0	·0	·0	–	–	·0*	·0*
XII.	–	·0	·0	·1	·0*	·0*	·0	·0	·0*	–	–	–
XIII.	·0	·0	·1	1·2	·2	·0	13·3*	·0	·0	1·6	2·6	·3
XIV.	·5	·0	·0	·0*	·0	·0	·0	·0	·0	·0	·0	·9
XV.	·1	·1	·3	·6	·0	·0*	–	·0	·0*	·0	·3	·5
XVI.	·0	·0	·1	·5	–	–	–	–	–	–	·0	0
XVII.	·0	·0	·5	·7	·7	·4	3·0	1·5	1·2	1·2	1·1	·7
XVIII.	·9	·5	1·2	1·2	1·1	·1	·0	·1	·3	·6	1·1	·2
XIX.	·0	·1	·0	·0	·0	·0	·0	·0	·0	·0	·0	·1
XX.	·0	·0	·0	·0	–	–	–	–	·0	–	·6	·1
XXIII.	·3	·2	·1	·4	·5	·1	·4	2·8	1·7	2·3	1·4	1·1
XXIV.	·0*	–	3·3*	1·1	–	·0*	·0	·0	·9	·5	·8	·0
XXV.	–	·0*	–	–	·0	–	·0*	·0*	·0	·0	·2	1·8
XXVIII.	·0*	·0	·0	–	·0*	·4	2·0	3·1	1·9	2·7	2·8	·1
XXIX.	·0	·7	·4	·2	·1	·2	1·2	8·7	5·9	5·7	3·1	5·3
XXX.	–	·0*	–	–	–	·0*	–	·6	·0	·4	·2	–
XXXI.	–	–	–	–	–	–	·0	·0	·1	·0	·0	–
XXXII.	–	–	–	–	–	–	·0	·0	·0	–	·5	·0*
C.	1·1	·0	·0	·0	·0	·2	·0	·0	·0	1·7	2·1	·0
D.	·0	·0	·0	·0	–	·0	·0	–	·0	2·5	·0	·0
K.	·8	·0	·0	·0	9·5	–	3·6	·0*	–	–	–	·0*
Var. N. Sea.	·9	0·1	·2	·4	·3	·1	·2	1·0	·3	·2	·4	1·1
C.D. Minch.	·0	·9	·2	·2	·5	·3	·9	·0	·0	5·0	·2	2·1
Western Grounds.	·0	·0	·0	14·2	·2	·0	3·8	·0	1·0	·0*	·0	·0
Faroe.	·0	·0	·1	·0	·0	·0	·0	·0	·1	·0	·0	·0

No Gurnards recorded from Areas VIII., XXII., XXVI., XXVII., XXXIII.–XLIII., J., L., M., S., Minch, Rockall, Iceland, Norway, White Sea.

Area VII., Apr. 3·1, May 0·0*, Nov. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Catfish,** in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	·2	·1	·6	·8	1·8	–	–	–	–	·2	·1	–
IX.	–	–	–	·0*	·8	1·6	1·7	4·4	·0*	·0*	–	–
X.	·3	·7	·8	·8	1·3	3·1	1·6	·5	·8	·1	·1	·2
XI.	·3	1·8	2·4	2·4	3·1	4·6	3·3	2·5	–	–	·0*	·0*
XII.	–	·3	2·3	2·0	3·6*	3·1*	4·5	1·9	1·0*	–	–	–
XIII.	·1	1·1	2·6	1·4	4·3	10·7	11·7*	1·6	1·2	·4	·9	·1
XIV.	1·3	2·6	4·1	11·9*	18·8	12·1	5·7	1·5	1·3	·4	·1	·2
XV.	·6	2·2	3·4	5·1	4·7	3·3*	–	·8	4·2*	·1	·1	·1
XVI.	·4	1·3	2·0	1·7	–	–	–	–	–	–	·2	·3
XVII.	1·4	4·5	3·7	3·7	3·7	5·6	3·3	1·8	·9	·8	·4	·7
XVIII.	·8	2·3	2 6	5·4	5·4	3·9	1·7	2·0	1·3	·5	·2	·2
XIX.	·3	·9	3·1	1·2	4·1	2·0	1·5	1·7	1·0	·2	·3	·1
XX.	·8	·7	1·6	1·4	–	–	–	–	·4	–	·2	·2
XXIII.	1·6	4·1	3·3	6·1	5·7	5·3	3·7	2·3	1·6	1·1	·8	·8
XXIV.	·0*	–	3·8*	1·8	–	9·6*	5·4	2·2	1·5	·7	1·3	·8
XXV.	–	·0*	–	–	17·3	–	·3*	·0*	·3	·2	·4	·3
XXVI.	–	–	6·6*	–	–	–	–	·5	·6	·1	·1	·1
XXVIII.	9·8*	20·5	24·3	–	29·0*	6·4	7·8	7·2	2·5	2·6	3·0	3·9
XXIX.	2·7	5·7	6·0	10·1	7·2	12·1	8·4	4·0	3·1	2·4	1·9	1·7
XXX.	–	·0*	–	–	–	7·9*	–	1·4	·5	·7	·7	–
XXXI.	–	–	–	–	–	–	2·5	·0	·9	·4	·1	–
XXXII.	–	–	–	–	–	–	1·9	·8	·9	–	·3	·5*
C.	·1	·2	·1	·3	·7	·6	·7	·0	·4	·0	·0	·0
D.	·2	·2	1·9	2·1	–	1·4	1·1	–	·0	1·7	·1	·2
K.	·0	·0	·0	·1	·0	–	·0	·0*	–	–	–	·0*
Var. N. Sea.	·5	2·0	2·2	2·1	3·8	4·3	4·7	1·9	·8	·5	·4	·2
C.D Minch	·1	2·1	2·3	1·6	1·7	1·5	1·7	·4	·7	·1*	·0	·1
Western Grounds	·0	·1	·0	·1	·0	·1	·0	·0	·0	·0*	·0	·0
Faroe.	10·4	27·1	39·0	14·6	15·7	21·4	16·1	8·1	1·5	1·1	·6	1·4
Iceland	6·0	3·2	8·7	6·3	7·8	8·5	6·8	3·6	1·6	·9	3·7	1·0

No Catfish recorded from Areas XXXVI.–XLIII., J., L., M., S., Rockall.

Area VII., Apr. ·8, May 0·0*, Nov. 0·0* ; VIII., Apr. ·6, May 3·5, July 3·4, Aug. 3·4 ; XXII., Jan. ·9*, Feb. 3·1, Dec. ·8* ; XXVII., July 1·4*, Aug. ·5, Sept. 1·9 ; XXXIII., Aug. 3·1 ; XXXIV., Dec. ·5* ; XXXV., Aug. 1·6*, Sept. 0·0, Oct. ·1, Nov. 5·5 ; Minch, Jan. 0·0, Mar. ·7, Apr. 2·3, July 0·0* ; Norway, Apr. 0·0, May 1·0, Nov. ·6* ; White Sea, Aug. 15·3, Sept. 5·1, Oct. 1·8, Dec. 51·1*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Catch of **Monks**, in Cwts., per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	10·2	7·3	5·1	4·8	3·4	–	–	–	–	8·3	10·2	–
IX.	–	–	–	2·4*	3·3	1·4	5·2	4·2	3·2*	6·7*	–	–
X.	5·7	4·6	2·8	3·5	2·2*	1·6	2·2	3·8	6·1	9·7	9·2	6·0
XI.	4·9	2·6	3·1	2·5	3·3	2·8	5·4	2·5	–	–	9·2*	8·9*
XII.	–	3·6	3·0	4·1	4·8*	4·2*	4·0	4·8	7·7*	–	–	–
XIII.	10·1	3·3	1·0	1·4	2·3	3·1	13·8*	2·2	16·2	7·2	7·7	4·1
XIV.	5·3	4·6	3·6	9·5*	3·2	2·7	2·9	4·2	6·1	4·6	5·6	4·7
XV.	4·5	3·3	3·7	7·4	7·4	13·0*	–	5·0	8 3*	5·7	3·2	5·9
XVI.	2·6	·7	2·2	1·4	–	–	–	–	–	–	1·5	2·4
XVII.	2·0	3·2	1·4	·9	1·3	1·9	2·1	1·4	3·8	3·1	3·0	3·4
XVIII.	6·8	6·1	4·7	1·9	5·2	7·1	5·3	5·3	5·5	5·5	7·3	6·2
XIX.	4·5	3·4	2·1	3·5	9·7	8·7	7·0	3·3	4·1	5·6	3·1	3·5
XX.	1·5	·8	1·4	1·2	–	–	–	–	·8	–	1·3	1·2
XXIII.	4·3	3·0	1·7	2·4	2·9	3·1	4·8	5·4	4·6	4·7	3·6	3·3
XXIV.	·0*	–	6·5*	4·0	–	3·8*	4·7	3·4	5·3	1·9	2·9	4·3
XXV.	–	·0*	–	–	2·5	–	1·4*	·0	·5	1·7	1·9	1 8
XXVI.	–	–	1·3*	–	–	–	–	·3	·6	1·0	·7	·8
XXVIII.	1·8*	1·0	1·1	–	·0*	1·9	·8	3·0	1·0	1·9	2·9	2·1
XXIX.	2·1	1·7	1·1	1·3	2·1	3·1	3·7	4·9	3·8	3·9	2·8	2·8
XXX.	–	6·7*	–	–	–	·7*	–	·6	·3	1·2	·9	–
XXXI.	–	–	–	–	–	–	1·1	·1	·3	·6	·8	–
XXXII.	–	–	–	–	–	–	·0	·2	·4	–	·7	3·1*
C.	·9	1·1	1·6	1·5	1·6	1·1	1·6	2·2	3·0	2·5	5·2	1·6
D.	1·1	·5	·9	·2	–	1·0	·7	–	4·7	2·7	2·4	4·1
J.	·0*	·0	1·1*	–	1·7*	1·6	–	2·4	–	–	·0*	·0*
K.	7·3	3·3	2·4	·0	1·8	–	2·7	2·1	–		–	·0*
Var. N. Sea.	4·8	4·9	3·2	3·5	3·1	2·5	3·1	3·7	3·4	3·7	3·6	4·7
C.D. Minch.	2·7	3·1	·9	·5	1·4	2·3	1·1	1·6	4·1	5·0	3·7	2·3
Western Grounds.	2·6	2·7	2·0	2·2	1·0	1·3	·7	2·2	1·2	1·2*	4·3	2·0
Faroe	1·2	·7	·4	·4	1·8	1·5	1·6	2·9	3·0	3·0	3·5	·8
Iceland	·5	·2	·0	·0	·1	·1	·4	1·0	1·6	1·3	·7	·5

No Monks recorded from Areas XXXVI., XL., XLIII., White Sea.

Area VII., Apr. 5·6, May 3·0*, Nov. 10·6*; VIII., Apr. 1·3, May 1·8, July 4·6, Aug. 10·9; XXII., Jan. 4·3*, Feb. 5·7, Dec. 3·2*; XXVII., July 0·0*, Aug. ·7, Sept. 1·9; XXXIII., Aug. ·4; XXXIV., Dec. 2·4*; XXXV., Aug. 0·0, Sept. 0·0, Oct. ·2, Nov. 1·0; M., Feb. 0·0*, May 8·0, Aug. 2·3, Sept. 0·0*; L., July 1·9*; S., June 3·3*, Nov. 2·8*; Minch, Jan. 27·6, Mar. 1·3, Apr. ·8, July 12·5*; Rockall, June 1·3*; Norway, Apr. 0·0, May 3·1, Nov. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Mackerel**, IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI. . .	·0	1·7	1·5	·5	·0	–	–	–	–	·0	·0	–
IX. . .	–	–	–	·0*	·0	·0	·1	·5	·0*	·0*	–	–
X. . .	·1	·2	·3	·9	·1	·0	·1	·6	·4	·1	·0	·0
XI. . .	11·8	1·9	5·5	6·1	·3	·0	·0	·6	–	–	·0*	·0*
XII. . .	–	14·1	3·3	4·4	·0*	·0*	·0	·1	·0*	–	–	–
XIII. .	·0	·0	·1	·9	·3	·0	·0*	·0	·0	·2	·0	·0
XIV. . .	·8	·5	·6	·0*	·0	·0	·0	·1	·1	·0	·5	·1
XV. . .	1·7	2·4	4·7	·6	·1	·0*	–	·8	·7*	·0	·0	1·4
XVI. . .	1·3	·6	5·8	7·5	–	–	–	–	–	–	·0	·8
XVII. .	·0	·1	·4	·4	·0	·0	·0	·0	·0	·0	·0	·0
XVIII. .	1·2	·2	·6	1·5	·0	·0	·1	·2	·2	·5	·1	·5
XIX. .	2·0	1·7	23·3	2·5	·0	·0	·0	·0	·3	·8	1·2	·7
XX. . .	·2	·7	·2	5·2	–	–	–	–	2·0	–	·3	·7
XXIII. .	·0	·0	·0	·0	·0	·0	·1	·1	·1	·2	·0	·0
XXIV. .	·0*	–	·0*	1·1	–	·0*	·0	·0	·6	·4	·0	·9
XXV. .	–	·0*	–	–	2·2	–	·0*	·0*	·2	3·8	1·0	·0
XXVI. .	–	–	·0*	–	–	–	–	·6	·3	4·4	1·6	·0
XXIX. .	·0	·0	·0	·0	·0	·0	·0	·1	·0	·0	·0	·0
XXX. .	–	·0*	–	–	–	·0*	–	·6	·3	1·3	·4	–
XXXI. .	–	–	–	–	–	–	6·7	2·5	·9	8·8	1·7	–
XXXII. .	–	–	–	–	–	–	·9	·8	·2	–	·1	3·6*
C. . .	·5	1·2	·0	1·3	·0	·1	2·4	2·6	6·0	3·6	6·2	·0
D. . .	·2	·9	·2	·2	–	·0	·4	–	·9	·0	·0	·0
J. . .	2·8*	·9	1·4*	–	·0*	·0	–	·0	–	–	4·2	* ·0*
K. . .	·0	1·7	·3	·0	·0	–	5·0	·0*	–	–	–	·0*
Var. N. Sea.	·8	·8	2·3	2·1	·3	·0	·0	·4	·4	·6	·8	·2
C.D. Minch.	·0	·0	·1	·0	·0	·0	3·6	·8	1·2	·9	7·2	·0
Western Grounds .	·0	·0	·0	1·1	·2	·0	1·6	1·2	·0	9·5*	1·6	·0

No Mackerel recorded from Areas VII., XXVIII., XXXIV., XLIII., L., S., Minch, Rockall, Faroe, Iceland, Norway, White Sea.

Area VIII., Apr. 0·0, May ·6, July ·1, Aug. 0·0 ; XXII., Jan. 0·0*, Feb. ·4, Dec. 0·0* ; XXVII., July 0·0*, Aug. 0·0, Sept. ·4 ; XXXIII., Aug. ·2 ; XXXV., Aug. 0·0*, Sept. 1·8, Oct. 3·3, Nov. 0·0 ; XXXVI., Sept. 7·4*, Oct. 0·0* ; XL., Sept. 6·9 ; XLIII., Sept. 0·0* ; M., Feb. 0·0*, May 0·0, Aug. 1·4, Sept. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE CATCH OF **Herrings,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
XII. . .	–	·0	·0	·0	·0*	·0*	·0	·5	6·7*	–	–	–
XIV. . .	·0	·0	·0	·0*	·0	·0	·4	2·5	·5	·4	·4	·0
XV. . .	·0	·6	·4	·0	·0	·0*	–	19·2	·0*	·5	·3	·0
XVI. . .	·1	·0	·5	·0	–	–	–	–	–	–	·0	·3
XVII. .	·0	·0	·0	·0	·0	·0	·0	·1	·6	·0	·0	·0
XVIII. .	·0	·0	·0	·0	·0	·1	6·6	6·3	2·3	·3	·0	·0
XIX. .	·2	·3	·0	·0	·0	·1	3·9	9·9	4·0	2·1	·9	·5
XX. . .	·0	·0	·0	·0	–	–	–	–	·5	–	·8	·5
XXIII. .	·0	·0	·0	·0	·0	·0	1·5	3·2	2·1	·0	·0	·0
XXIV. .	·0*	–	·0*	·4	–	·0*	1·4	6·7	4·2	5·3	·2	·0
XXV. .	–	·0*	–	–	·0	–	·0*	·0*	·8	14·9	·1	·0
XXVI. .	–	–	·0	–	–	–	–	·0	1·2	·0	·0	·0
XXVIII. .	·0*	·0	·0	–	·0*	·0	·4	·0	·0	·0	·0	·0
XXIX. .	·0	·0	·0	·0	·0	·0	·2	·7	·0	·0	·0	·0
XXX. .	–	·0*	–	–	–	·0*	–	1·0	3·7	12·7	2·8	–
XXXI. .	–	–	–	–	–	–	·1	50·3	3·8	6·6	·2	–
XXXII. .	–	–	–	–	–	–	·0	·1	·5	–	·1	·0*
C. . .	·0	·0	·0	·0	·0	·0	·0	1·1	·0	·0	·0	1·0
D. . .	·0	·0	·0	·0	–	·0	·0	–	·0	·0	·0	·0
J. . .	·0*	·0	·0*	–	·0*	·0	–	·0	–	–	·0*	·0*
K. . .	·0	·0	·0	·0	·0	–	·0	·5*	–	–	–	·0*
Var. N. Sea.	·0	·0	·1	·1	·0	·0	1·9	2·8	7·8	3·6	·6	·1
Faroe. .	·9	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0	·0
Iceland .	·0	·0	·0	·0	·0	·0	·0	·1	·0	·0	·0	·0

No Trawled Herrings recorded from Areas VI.–XI., XIII., XXII., XXVII., XXXIV., XLIII., D., J., L., S., Minch, Rockall, Faroe, Norway.

Area XXXIII., Aug. 1·4; XXXV., Aug. 264·4*, Sept. 389·2, Oct. 218·1, Nov. 1·4; XXXVI., Sept. 250·0*, Oct. 363·8*; XL., Sept. 179·6; M., Feb. 0·0*, May 0·0*, Aug. 182·2, Sept. 0·0*; White Sea, Aug. 2·6, Sept. 0·0, Oct. 0·0, Dec. 0·0*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

AVERAGE **Total Catch,** IN CWTS., PER 100 HOURS' FISHING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	587·1	712·4	372·4	462·5	363·9	–	–	–	–	295·2	382·9	–
IX.	–	–	–	441·4*	325·0	402·9	312·4	298·2	283·4*	305·2*	–	–
X.	433·4	445·4	370·3	440·1	331·6	369·4	415·6	279·7	286·2	306·5	264·8	218·1
XI.	428·1	291·2	315·0	361·2	375·3	377·0	480·0	296·7	–	–	328·1*	491·1*
XII.	–	461·4	252·7	275·4	165·6*	476·8*	322·1	322·5	174·0*	–	–	–
XIII.	287·9	365·1	248·6	142·8	344·8	340·7	2022·6*	217·8	333·7	360·7	301·6	234·0
XIV.	383·1	328·4	290·6	274·8*	391·1	301·0	336·3	276·9	283·7	265·0	276·5	277·1
XV.	263·2	302·3	277·9	297·3	231·0	283·0*	–	447·6	546·6*	306·0	213·8	229·7
XVI.	202·5	375·7	255·3	291·2	–	–	–	–	–	–	126·6	208·7
XVII.	274·3	203·6	315·4	226·1	146·7	211·5	210·0	205·4	174·2	182·7	157·0	166·5
XVIII.	262·2	226·0	231·7	180·0	132·4	247·0	333·1	281·6	216·7	216·7	191·9	207·8
XIX.	255·7	228·8	305·4	181·8	218·6	216·0	361·6	261·6	239·7	165·8	213·9	210·3
XX.	207·9	277·3	220·1	252·2	–	–	–	–	224·4	–	151·8	164·3
XXIII.	140·6	132·5	106·0	124·9	122·7	129·4	186·1	182·9	185·1	178·0	134·5	114·8
XXIV.	204·2*	–	245·2*	156·7	–	116·0*	136·5	163·6	217·8	228·9	165·8	160·6
XXV.	–	72·4*	–	–	96·4	–	42·5*	144·0*	199·6	184·4	178·4	212·5
XXVI.	–	–	376·8*	–	–	–	–	175·8	154·0	210·6	121·2	195·3
XXVIII.	133·4*	108·2	108·8	–	140·9*	110·2	104·0	149·6	129·7	135·6	135·5	94·0
XXIX.	84·4	84·8	119·3	119·5	109·8	123·5	119·3	130·3	132·1	136·7	141·8	116·4
XXX.	–	113·2*	–	–	–	161·1*	–	140·1	197·1	176·4	160·7	–
XXXI.	–	–	–	–	–	–	197·4	220·9	187·1	177·9	138·2	–
XXXII.	–	–	–	–	–	–	146·5	180·3	170·9	–	134·2	131·6*
C.	276·0	423·1	324·8	577·7	355·6	367·2	328·7	239·4	361·0	205·9	395·3	369·0
D.	454·4	290·2	475·8	428·8	–	225·4	230·3	–	607·4	292·0	166·4	391·3
J.	1418·4	718·8	354·8*	–	638·6*	360·2	–	345·1	–	–	1084·1*	417·0*
K.	428·4	915·7	973·9	922·6	376·7	–	220·2	284·4*	–	–	–	742·5*
Var. N. Sea.	292·4	272·2	281·0	329·2	266·4	244·4	272·0	236·0	184·6	202·7	185·5	204·1
C.D. Minch.	290·8	242·6	270·3	265·8	276·8	360·4	289·2	203·0	210·6	342·2	253·0	248·4
Western Grounds.	214·5	332·2	363·9	507·2	406·9	291·7	249·1	277·2	241·5	319·3	510·6	366·8
Faroe.	377·9	429·9	535·4	687·0	332·3	364·1	384·0	384·1	326·4	242·6	206·0	186·2
Iceland	1228·0	1376·6	1326·1	1402·5	1155·3	792·6	433·5	488·5	411·1	291·8	259·0	455·1

Area VII., Apr. 516·4, May 289·0*, Nov. 445·0*; VIII., Apr. 210·5, May 295·4, July 504·5, Aug. 421·1; XXII., Jan. 192·7*, Feb. 150·3, Dec. 115·5; XXVII., July 139·9*, Aug. 229·4, Sept. 244·1; XXXIII., Aug. 206·3; XXXIV., Dec. 98·1*; XXXV., Aug. 483·0*, Sept. 519·0, Oct. 323·6, Nov. 272·9; XXXVI., Sept. 292·8*, Oct. 386·5*; XL., Sept. 255·6; XLIII., Sept. 336·3*; M., Feb. 596·3*, May 263·7, Aug. 515·4, Sept. 619·4*; L., July 212·8*; S., June 627·0*, Nov. 235·8*; Minch, Jan. 378·0, Mar. 343·7, Apr. 282·6, July 628·0*; Rockall, June 694·8*; Norway, Apr. 1388·0, May, 652·4, Nov. 2948·7; White Sea, Aug. 930·0, Sept. 558·5, Oct. 503·4, Dec. 1668·4*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

Average Value of Catch, in Pounds Sterling, per 100 Hours' Fishing (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	274·0	231·7	164·6	191·4	189·9	–	–	–	–	188·0	222 1	–
IX.	–	–	–	246 7*	142·9	241·0	160·8	151 2	251·5*	228·8*	–	–
X.	277·9	222·8	201·3	193·3	182·8	191 9	206·0	169·3	196·5	187·8	173·3	188·0
XI.	311·0	144·5	209·6	200·1	251·0	170·4	184·9	136·8	–	–	251·5*	358·3*
XII.	–	176·4	172·3	151·8	94·0*	241·1*	121·4	143·2	98·6*	–	–	–
XIII.	228·5	198·5	213·4	92·2	158·3	181·4	1079·6	159·1	174·0	202·1	214·7	196·8
XIV.	268·5	182·6	187·8	195·1*	166·3	146·6	172·2	179·4	182·8	165·7	214·2	217·4
XV.	202·0	150·2	193·7	171·8	179·6	91·5*	–	124·7	311·7*	157·7	178·9	161·3
XVI.	182·6	154·2	183·7	163·0	–	–	–	–	–	–	155·3	188·7
XVII.	250·1	174·1	213·7	125·4	112·2	134·9	109·7	141·7	137·9	144·2	151·4	174·9
XVIII.	212·6	124·3	157·6	112·7	95·5	105·7	108·1	121·1	126·7	140·0	145·9	147·2
XIX.	215·8	153·3	226·3	89·4	118·6	104·9	115·0	96·5	130·8	96·4	171·8	147·5
XX.	232·1	173·9	279·0	142·9	–	–	–	–	214·9	–	157·9	160·9
XXIII.	135·9	109·4	109·4	96·7	100·5	89·1	97·0	100·2	117·4	124·5	112·1	103·4
XXIV.	266·6*	–	196·6*	73·0	–	123·9*	102·5	103·4	132·9	144·8	144·1	145·3
XXV.	–	67·5*	–	–	117·2	–	66·9*	147·2*	178·4	157·1	170·2	188·9
XXVI.	–	–	311·6*	–	–	–	–	155·4	144·9	250·2	120·8	238·4
XXVIII.	116·7*	92·7	101·6	–	104·4*	103·0	85·3	114·3	104·2	119·4	139·1	93·5
XXIX.	91·2	88·0	120·3	95·9	107·2	92·4	86·3	89·7	107·1	122·2	134·0	108·7
XXX.	–	86·4*	–	–	–	100·9*	–	129·5	159·6	142·9	142·2	–
XXXI.	–	–	–	–	–	–	126·3	145·5	163·2	165·1	143·6	–
XXXII.	–	–	–	–	–	–	124·9	163·0	156·4	–	164 2	136·4*
C.	270·1	264·6	206·8	266·7	221·2	204·4	185·8	152·3	290·9	259·4	304·6	560·5
D.	370·5	177·9	323·4	250·4	–	159·0	121·7	–	407·2	320·8	164·2	297·2
J.	1230·1	317·7	232·8*	–	382·1*	201·4	–	211·9	–	–	1182·9	364·3*
K.	274·3	413·0	411·3	325·3	134·2	–	166·9	262·2*	–	–	–	997·5*
Var. N. Sea.	222·8	159·2	173·7	154·9	134·3	126·0	126·9	122·7	127·7	144·9	148·5	157·1
C.D. Minch.	264·2	154·0	199·8	175·2	175 5	208·4	169·7	144·8	147·0	202·1	220·6	196·5
Western Grounds.	131·3	166·9	213·2	234·0	259·4	212·4	168·4	187·0	173·8	445·8*	361·4	385·4
Faroe.	338·1	275·2	361·1	317·2	204·2	193·0	177·5	238·3	222·6	215·3	207·2	182 5
Iceland	510·4	501·9	488·1	382·6	336·0	244·9	158·5	185·4	171·2	154·7	170·0	257 8

Area VII., Apr. 244·2, May 172·0*, Nov. 209·3*; VIII., Apr. 115·1, May 198·8, July 175·7, Aug. 193·2; XXII., Jan. 168·1*, Feb. 144·2, Dec. 94·0*; XXVII., July 102·7*, Aug. 210·7, Sept. 226·1; XXXIII., Aug. 167·0; XXXIV., Dec. 88·1*; XXXV., Aug. 160·2*, Sept. 295·2, Oct. 173·5, Nov. 231·3; XXXVI., Sept. 180·2*, Oct. 186·6; XL., Sept. 160·8; XLIII., Sept. 707·8*; M., Feb. 228·2*, May 126·3, Aug. 339·7, Sept. 457·9; L., July 139·6*; S., June 255·5*, Nov. 156·8*; Minch, Jan. 268·7, Mar. 315·7, Apr. 200·5, July 185·4; Rockall, June 311·3*; Norway, Apr. 720·8, May 465·4, Nov. 1400·4*; White Sea, Aug. 322·2, Sept. 223·6, Oct. 225·5, Dec. 604·4*.

* These averages have been derived from catches got in 100 hours' or in less than 100 hours' fishing.

PERCENTAGE (BY WEIGHT) OF **Cod**, IN TOTAL CATCH OF COD AND CODLING (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	52	49	40	58	41	–	–	–	–	35	39	–
IX.	–	–	–	46	35	63	50	30	53	36	–	–
X.	54	47	45	51	50	56	50	45	41	40	39	46
XI.	51	46	47	41	33	32	31	31	–	–	56	35
XII.	–	45	51	32	61	20	45	39	62	–	–	–
XIII.	42	68	62	77	56	31	51	15	61	66	69	47
XIV.	37	36	43	62	47	40	51	37	49	63	63	35
XV.	38	49	51	34	60	73	–	64	52	65	64	62
XVI.	49	50	57	34	–	–	–	–	–	–	39	53
XVII.	88	63	87	82	68	64	52	35	36	25	36	40
XVIII.	53	74	87	82	65	85	79	83	77	75	71	61
XIX.	43	56	59	41	55	65	77	86	70	62	61	54
XX.	53	66	51	59	–	–	–	–	34	–	62	60
XXIII.	63	64	61	73	70	65	67	58	67	36	39	32
XXIV.	20	–	86	79	–	81	88	90	89	73	58	63
XXV.	–	46	–	–	73	–	17	11	53	54	54	57
XXVI.	–	–	66	–	–	–	–	38	38	43	42	58
XXVIII.	44	28	17	–	28	30	23	9	6	8	11	21
XXIX.	42	55	83	78	44	23	29	24	14	22	11	32
XXX.	–	40	–	–	–	27	–	43	67	65	64	–
XXXI.	–	–	–	–	–	–	60	45	59	56	53	–
XXXII.	–	–	–	–	–	–	46	29	32	–	38	64
C.	62	52	71	79	53	68	52	33	26	56	58	43
D.	58	43	75	76	–	66	69	–	20	27	32	45
J.	3	73	35	–	51	79	–	57	–	–	53	72
K.	90	75	94	94	71	–	46	29	–	–	–	36
C.D. Minch.	62	71	75	68	61	55	57	32	27	51	49	43
Western Grounds.	64	64	79	76	60	70	58	41	56	46	48	69
Faroe.	10	16	28	40	17	13	8	11	10	13	12	9
Iceland	89	93	87	88	73	53	73	66	66	83	87	86

Area VII., Apr. 22, May 27, Nov. 61; VIII., Apr. 46, May 23, July 47, Aug. 28; XXII., Jan. 65, Feb. 63, Dec. 38; XXVII., July 19, Aug. 26, Sept. 34; XXXIII., Aug. 41; XXXIV., Dec. 31; XXXV., Aug. 89, Sept. 83, Oct. 64, Nov. 63; XXXVI., Sept. 89, Oct. 73; XL., Sept. 60; XLIII., Sept. 38; M., Feb. 20, May 83, Aug. 42, Sept. 31; L., July 66; S., June 58, Nov. 68; Minch, Jan. 76, Mar. 60, Apr. 69, July 75.

Percentage (by Weight) of **Small and Extra Small Haddock,** in Total Catch of Haddocks (Aberdeen Trawlers)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI. . .	24	16	27	31	35	–	–	–	–	40	37	–
IX. . .	–	–	–	13	26	17	21	28	18	38	–	–
X. . .	18	32	29	29	28	16	18	23	28	49	42	44
XI. . .	51	41	33	38	31	14	13	16	–	–	39	51
XII. . .	–	29	30	33	84	8	15	14	94	–		–
XIII. .	29	64	63	54	35	30	31	40	66	55	39	34
XIV. . .	45	52	52	64	31	23	23	32	43	54	38	29
XV. . .	54	46	42	60	74	93	–	92	72	59	43	54
XVI. . .	51	31	32	27	–	–	–	–	–	–	47	41
XVII. .	72	69	70	60	64	60	63	41	55	53	47	36
XVIII. .	67	73	75	82	86	96	95	95	89	78	84	60
XIX. .	60	51	47	65	74	80	94	90	59	80	49	51
XX. . .	46	43	31	40	–	–	–	–	21	–	33	41
XXIII. .	69	64	66	75	79	79	73	71	80	70	69	64
XXIV. .	46	–	66	67	–	85	82	82	83	59	54	54
XXV. .	–	33	–	–	42	–	22	36	21	28	35	51
XXVI. .	–	–	25	–	–	–	–	18	23	17	26	20
XXVIII. .	44	35	28	–	66	56	66	66	63	53	57	47
XXIX. .	64	46	45	58	73	73	74	72	68	66	63	67
XXX. .	–	80	–	–	–	83	–	38	37	45	46	–
XXXI. .	–	–	–	–	–	–	34	23	23	25	23	–
XXXII. .	–	–	–	–	–		30	18	16	–	17	34
C. . .	16	27	33	30	29	22	26	24	23	35	30	12
D. . .	17	26	31	39	–	21	21	–	13	5	27	25
J. . .	22	21	18	–	26	31	–	23	–	–	21	28
K. . .	57	23	38	29	53	–	25	18	–	–	–	18
C.D. Minch.	26	49	61	36	32	25	30	26	34	28	32	29
Western Grounds .	45	34	43	26	27	19	28	17	14	8	28	21
Faroe. .	19	18	17	12	17	12	11	10	15	20	7	10
Iceland .	0	0	0	0	0	0	2	3	7	25	15	0

Area VII., Apr. 34, May 26, Nov. 46; VIII., Apr. 33, May 31, July 19, Aug. 16; XXII., Jan. 83, Feb. 69, Dec. 69; XXVII., July 36, Aug. 9, Sept. 11; XXXIII., Aug. 24; XXXIV., Dec. 69; XXXV., Aug. 42, Sept. 78, Oct. 42, Nov. 25; XXXVI., Sept. 52, Oct. 28; XL., Sept. 65; XLIII., Sept. 16; M., Feb. 27, May 50, Aug. 25, Sept. 19; L., July 16; S., June 26, Nov. 0; Minch, Jan. 62, Mar. 37, Apr. 31, July 100.

PERCENTAGE (BY WEIGHT) OF **Small Plaice**, IN TOTAL CATCH OF PLAICE (ABERDEEN TRAWLERS)—1913.

Area.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VI.	0	0	0	0	0	–	–	–	–	0	–	–
IX.	–	–	–	0	0	0	0	0	–	57	–	–
X.	37	0	33	6	13	3	1	0	0	10	21	22
XI.	0	0	0	0	0	–	–	0	–	–	–	–
XII.	–	0	13	0	–	–	–	0	–	–	–	–
XIII.	32	13	21	16	12	6	12	20	0	12	33	4
XIV.	0	2	17	–	2	2	8	0	0	10	0	5
XV.	0	7	0	0	–	–	–	–	0	0	–	0
XVI.	–	0	0	0	–	–	–	–	–	–	0	0
XVII.	6	9	13	14	11	5	13	12	3	2	2	6
XVIII.	5	2	9	8	0	16	0	0	0	10	0	0
XIX.	13	0	–	0	–	0	0	0	0	0	0	0
XX.	0	0	0	–	–	–	–	–	8	–	3	0
XXIII.	39	17	28	14	13	25	23	21	43	27	46	37
XXIV.	–	–	0	0	–	0	0	0	0	0	2	–
XXV.	–	32	–	–	0	–	0	16	2	4	0	0
XXVI.	–	–	0	–	–	–	–	3	5	1	1	0
XXVIII.	27	19	26	–	55	68	54	61	80	78	57	48
XXIX.	9	11	6	13	6	4	6	3	5	11	16	21
XXX.	–	–	–	–	–	0	–	0	5	0	0	–
XXXI.	–	–	–	–	–	–	0	0	3	3	2	–
XXXII.	–	–	–	–	–	–	17	5	6	–	2	0
C.	0	0	12	17	–	8	0	0	0	3	0	2
D.	3	25	26	9	14	24	0	–	23	5	7	11
J.	–	0	68	–	0	0	–	0	–	–	–	0
K.	0	29	0	0	0	–	18	0	–	–	–	–
C.D. Minch	9	16	16	15	17	13	53	31	27	3	48	11
Western Grounds	0	9	40	7	29	7	16	14	26	0	28	0
Faroe.	0	4	1	2	0	0	14	0	4	0	0	0
Iceland	24	0	6	1	1	0	3	6	5	27	12	6

Area XXII., Jan. 0, Feb. 22, Dec. 33; XXVII., July 7, Aug. 5, Sept. 17; XXXIII., Aug. 6; XXXIV., Dec. 0; XXXV., Aug. 0, Sept. 0, Oct. 0, Nov. 0; XL., Sept. 0; XLIII., Sep. 56; M., Feb. 22, Aug. 43, Sept. 52; L., July 0; Minch, Jan. 0, Mar. 16, Apr. 30, July 0.

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SCIENTIFIC INVESTIGATIONS,

1914.

No. IV.

ON MEAN SEA LEVEL AND ITS FLUCTUATIONS.

By Professor D'ARCY W. THOMPSON, C.B.

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ON MEAN SEA LEVEL AND ITS FLUCTUATIONS.

By D'ARCY WENTWORTH THOMPSON.

Few data are more often referred to than "sea level," and few physical constants are so little known and so inaccurately determined.

The mean between two consecutive tides, high and low, is our first approximation to the mean level of the sea; and it becomes a better and better approximation when we take these means for a more and more lengthened period. In certain cases this method is apt to fail us. For it may happen, for instance, that at certain places the tide stands for a comparatively long period in the neighbourhood of high water, and makes a more abrupt rise and fall when near the ebb; where, in other words, the tide-gauge records an unsymmetrical wave. In such a case as this the mid-height between high and low water is obviously not the mean level of the sea, and this mean level must be determined by integrating, or determining the area of, the recorded curve. In ordinary cases, however, and wherever, as is the case on the East Coast of Scotland, the record of the tide-gauge gives us a fairly simple and regular wave, the "mean-tide-level" or the mean height between high water and low water, is a fair approximation to the mean level of the sea.

But it is well known that if this mean level be determined month by month, and year by year, the values so determined will show marked and even large fluctuations. The mean for one year is not identical with that for the next, and, within a single year, the mean monthly values group themselves into a more or less regular, and annually recurrent, periodic series. There exist, in short, certain "tides of long period," the chief of which are the annual and semi-annual tides; and over and above these, there are fluctuations from year to year, of which we know very little, and in which no regular periodicity has yet been traced.

The study of mean sea level and its fluctuations is interesting from several points of view. Firstly, it is of practical importance to determine what mean sea level is, inasmuch as it is, or is supposed to be, the datum to which all heights are referred in our national survey. As a matter of fact, this datum is an arbitrary one. The actual mean sea level has never been determined with accuracy; and it would seem, from the conditions of the case, that all we can do is to approach slowly, during a long course of years, to an approximate determination.

Secondly, while the annual and semi-annual tides (*Sa* and *Ssa*) are well known, and have been determined for a number of ports, and are taken careful account of in tide-prediction, their origin and nature are still very little understood. They are known to be of greater magnitude than can be accounted for by astronomical conditions: they are described as "meteorological" tides, and are generally

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referred to the action of winds, or to the effect of rainfall, or to direct barometrical pressure, or to other causes of a like nature. The nature and the causes of the fluctuations which mean sea level is subject to during still longer periods, from one year to another, are at present still more obscure.

Thirdly, though the connection of this fluctuation of sea level with fishery problems may be remote, yet it is at least conceivable. A difference in the level of the North Sea amounting to somewhere about 6 inches on the average between May and December, or a change in the whole annual mean sea level of say 3 or 4 inches from one year to another, must involve the transference of an immense body of water, and must appreciably affect the composition and the salinity of the sea itself. It forms some part, at least, of that complex phenomenon which we seek to study in our hydrographical investigations, and which we may be able some day to correlate with periodic phenomena in the life history and the fluctuating abundance of our food fishes.

By the kindness of Mr. R. Gordon Nicol, and of Mr. J. Hannay Thompson, the Harbour Engineers at Aberdeen and Dundee, I have had access to a long series of tide records kept at the dock gates of these two ports. The Dundee observations were taken at the dock gates of King William's Dock, the harbour datum being from the sill of the lock entrance, which is 9·74 ft. below ordnance datum level. Those at Aberdeen were taken at the Victoria Dock gates, the harbour datum being the sill of the lock entrance, which is 14·62 ft. below ordnance datum level. The mean sea level at Dundee from 1897 to 1912 is found to be 10·39 ft. above harbour datum; *i.e.* ·65 ft. above ordnance datum. Mean sea level at Aberdeen for the same period, and also for the entire period 1862–1913, was found to be in each case 15·60 ft. above harbour datum; *i.e.* ·98 ft. above ordnance datum. This discrepancy, amounting to ·33 ft. between the height of mean sea level in relation to ordnance datum at Dundee and Aberdeen, is not explained. It is, however, precisely akin to similar local differences of level that have been detected on the coast of France, for instance, and in many other parts of the world, as described by Krümmel (*op. cit.* p. 64) and other writers. It is very noteworthy that the direction of the prevailing current on our East Coast, from North to South, corresponds to this observed fact of the higher mean level of the sea at the northern, as compared with the more southern, station.

Mr. Gordon Nicol tells us that at Aberdeen he assumes high water of ordinary spring tides as 22 ft. and low water of ordinary spring tides as 9 ft. 3 in. above harbour datum. The mean of these two, viz. 15·625 ft., agrees as nearly as possible with the mean value that we have found for the tides as a whole. The Aberdeen records run from the beginning of the year 1862 to the end of 1913, with only a single break of three months, from March to June 1875; those of Dundee begin with the year 1897, and go on continuously to the present time, but they have only been worked up to the end of 1912. In both cases the observations give the height of the tide at high and low water. They are simply made by eye, to the nearest inch, upon a vertical scale, no recording tide-gauge being in use. Nevertheless, the observations have been so carefully and so regularly recorded, and the consecutive period over which they extend is so long, that they seem well adapted for throwing light upon our problem.

Here I may mention, in parenthesis, that, though the fluctuations which we wish to determine involve differences in the monthly means amounting sometimes to only a few hundredths of a foot, it is by no means necessary that the observations on which these are based should be correct even to an inch. As a matter of fact, they are not so. If we analyse the observations, we soon see that personal equation has led to a large excess of readings at particular intervals, 6 in. being the most frequent, and 3 and 9 in. coming next in order. But, what

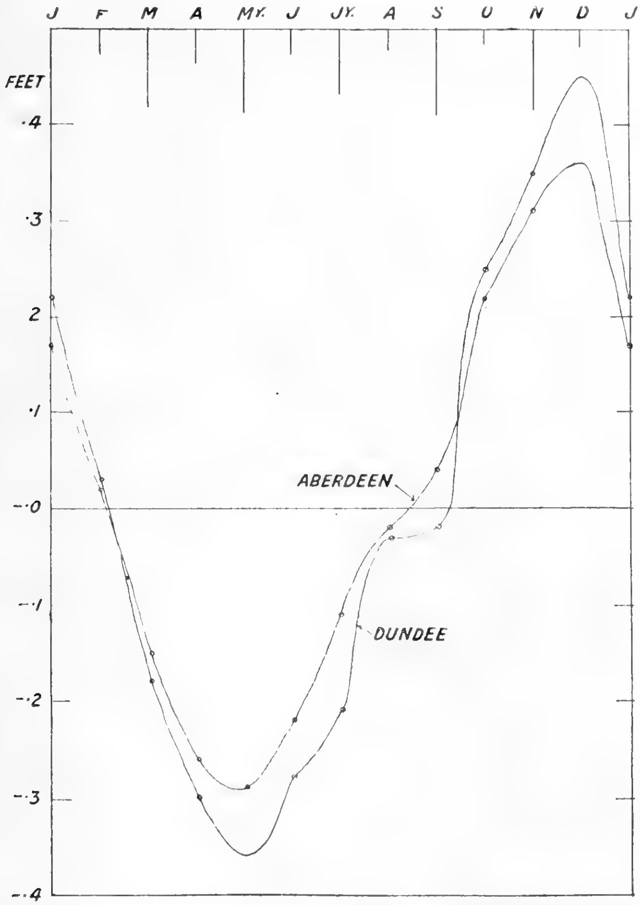

Fig. 1.—Mean Sea Level (in ft.) at Dundee (1897–1912) and Aberdeen (1862–1913): Mean Monthly Values compared with the Mean for the whole period.

is more curious, it seems to me that, in such long series as these, observations made to the nearest *foot* would do very nearly as well. At Aberdeen, both high and low water vary over a range of several feet; high water from something over 16 ft. to over 23 ft., and low water in like manner, from about 7 to 14 ft., above the sill of the dock gates. Now, over a large range such as this, the precise number of *inches* will, in the long run, fall under the doctrine of averages.

The average value of the odd inches will be, in the long run, $\frac{0+1+2+3\ldots+11}{12}=\frac{66}{12}$, or 5·5 in., *i.e.* ·46 of a foot. Taking at random the month of December 1907, in which month we had 118 readings of high and low water at Aberdeen, we find that the individual

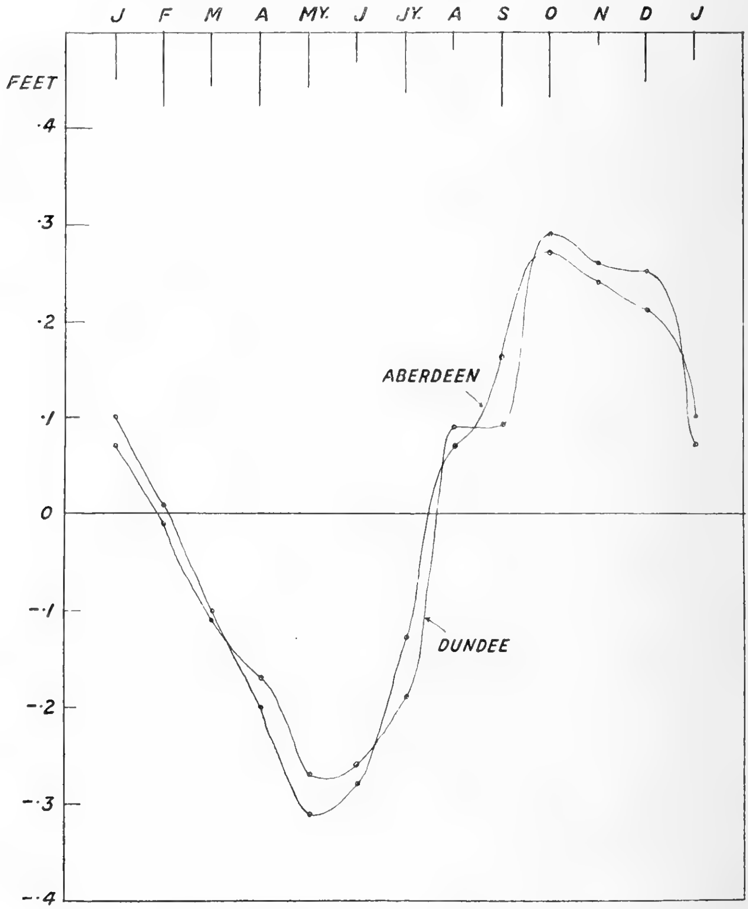

Fig. 2.—Mean High Water Level: Dundee and Aberdeen.

readings were as follows, as regards the number of odd inches recorded:—

Inches:	0	1	2	3	4	5	6	7	8	9	10	11
No. of readings:	17	4	8	18	4	5	17	10	7	14	7	7'

the mean value of these being 616/118=5·22 in., or only ·28 in., or ·023 ft., short of what we might expect in a long series, from the law of averages.

But if we assume that the recorded readings at 0, 3, 6, and 9 in. will be, say, twice as numerous as those at the intermediate points, an assumption which is not far off from what we actually find to be the case, then, in a long series, the mean of the recorded inches will

approximate, not to 5·5 in., but to 84/16=5·25 in. And this is almost precisely what we actually find, both in the above random example and in others which I have worked out. It would seem, in short, that we should lose very little indeed were we to save ourselves the trouble of adding up the odd inches in all these multitudinous observations! This, however, has not been done.

I. The Annual and Semi-Annual Tides.

In the annexed Tables (I.–III. pp. 37, 38) are shown the monthly means for Dundee, of high water (II.), of low water (III.), and of mean sea level (I.) as above defined, that is to say, the mid-height between the two foregoing values; and these results are further reduced to annual means, and to the monthly means for the whole period of sixteen years. In Tables IV.–VI. (pp. 39–41) the same data are given for the still longer and more important records, covering no less than fifty-two years, which I have received from Aberdeen. The phenomena at the two ports are very similar, and the mean results are set forth and compared in the following epitomised table :—

Table A.—Departures from the Annual Mean of the Monthly Mean Values of Mean Sea Level, Mean High Water, and Mean Low Water, at Aberdeen (1862–1913) and Dundee (1867–1912), in feet :—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
						Mean Sea Level.						
Dundee .	·22	·03	–·18	–·30	–·36	–·28	–·21	–·03	–·02	·25	·35	·45
Aberdeen.	·17	·02	–·15	–·26	–·29	–·22	–·11	–·02	·04	·22	·31	·36
Difference	·05	·01	–·03	–·04	–·07	–·06	–·10	–·01	–·06	·03	·04	·09
						Mean High Water.						
Dundee .	·07	–·01	–·11	–·17	–·27	–·26	–·19	·09	·09	·29	·26	·25
Aberdeen.	·10	·01	–·10	–·20	–·31	–·28	–·13	·07	·16	·27	·24	·21
Difference	–·03	–·02	–·01	·03	·04	·02	–·06	·02	–·07	·02	·02	·04
						Mean Low Water.						
Dundee .	·38	·09	–·23	–·40	–·42	–·27	–·22	–·13	–·11	·24	·47	·66
Aberdeen.	·24	·02	–·20	–·32	–·28	–·17	–·10	–·12	–·09	·17	·38	·50
Difference	·14	·07	–·03	–·08	–·14	–·10	–·12	–·01	–·02	·07	·09	·16
						The Differences smoothed.						
M. S. L. .	·05	·01	–·02	–·05	–·06	–·08	–·06	–·06	–·01	·00	·05	·06
M. H. W. .	·00	–·02	·00	·02	·03	·00	·01	–·04	·02	·01	·03	·01
M. L. W. .	·12	·06	–·01	–·08	–·11	–·12	–·08	–·05	·01	·05	·11	·13

We now see that, in each of our three factors, mean sea level, mean high water, and mean low water, a definite annual wave is apparent. In the case of Mean Sea Level (Fig. 1), this annual wave has its minimum about the month of May, and its maximum in December. The wave is similar but not identical, in phase and amplitude, for high water and for low (Figs. 2, 3).

In the annual wave of Mean Sea Level, the total amplitude is less at Aberdeen than at Dundee, viz. about ·65 ft. as against ·81 ft.; but the phase, so far as can be seen by inspection, is identical. In the case of Mean Low Water, the phase is apparently a little earlier at Aberdeen, the minimum being in April instead of May; the amplitude is considerably less, viz. ·82 ft., as against 1·06 ft. at Dundee. In the case of Mean High Water, the phases are alike, and the ampli-

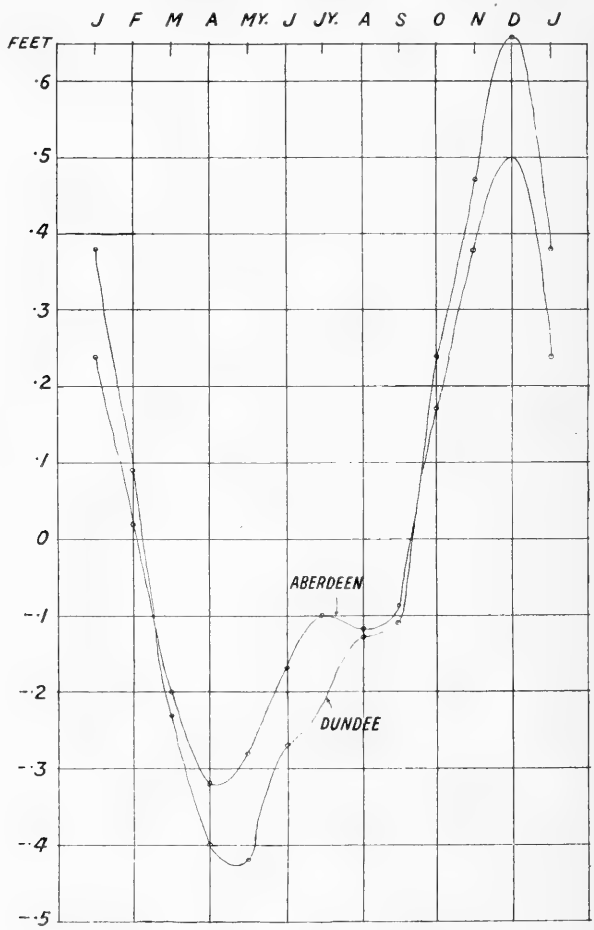

FIG. 3.—Mean Low Water Level: Dundee and Aberdeen.

tudes also are all but identical, viz. ·58 ft. at Aberdeen and ·56 ft. at Dundee.

Such differences as there are between the two stations are not without a striking, and periodic, regularity. If we examine them as they are set forth in the above Table, and especially when the successive monthly values are "smoothed" (by taking the successive means of three adjacent months), we see that the differences between the monthly values at Dundee and Aberdeen, in the case of Mean Sea Level and Mean Low Water, approximate in each case to a sine curve, showing identical values at the two stations about February

and September, while the departure from the mean has a maximum in November or December, and a negative maximum in May, in favour of Dundee. In the case of Mean High Water, the differences are of less magnitude, and they approximate to a double, or semi-annual sine curve, with positive maxima about May and November, and negative maxima about February and August.

The harmonic analyses of our data elucidate these rough preliminary results :—

TABLE B.—Harmonic Formulæ for the Mean Annual Variation in Mean Sea Level, Mean High Water, and Mean Low Water, at Dundee and Aberdeen (*Epoch* : mid-January).

M. S. L.	Dundee	$A+\cdot36\cos(t+50°)+\cdot06\cos(2t+51°)$
	Aberdeen	$A+\cdot28\cos(t+58°)+\cdot07\cos(2t+41°)$
M. H. W.	Dundee	$A+\cdot26\cos(t+61°)+\cdot05\cos(2t+53°)$
	Aberdeen	$A+\cdot25\cos(t+58°)+\cdot05\cos(2t+78°)$
M. L. W.	Dundee	$A+\cdot46\cos(t+45°)+\cdot16\cos(2t+48°)$
	Aberdeen	$A+\cdot32\cos(t+46°)+\cdot14\cos(2t+54°)$

We see at once from these formulæ that there is an important difference between the two stations in the *amplitudes* of the annual wave in the case of Mean Sea Level and Mean Low Water, and, on the other hand, a considerable difference in the *phase* of the semi-annual wave in the case of Mean High Water. But as regards this last, it must be remembered that, owing to the very small amplitude of the semi-annual wave, we cannot expect, with the means at our disposal, to have determined its phase with very great accuracy.

In individual years, the characters of these waves are maintained with very considerable constancy. In the case of Mean Sea Level, I have set forth in an epitomised Table (Table C) the average discrepancies between the individual monthly means and the corresponding aggregate monthly means for the entire period.

TABLE C.—Mean Sea Level at Dundee (1897–1912) and Aberdeen (1862–1913). Mean of the Discrepancies (in feet, irrespective of sign), in individual months, from the Monthly Means for the entire period.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Dundee .	·15	·26	·18	·14	·11	·10	·08	·09	·14	·15	·11	·16	·14
Aberdeen .	·23	·24	·17	·13	·13	·14	·10	·10	·14	·15	·17	·17	·19
The same smoothed.													
Dundee .	·19	·20	·19	·14	·12	·10	·09	·10	·13	·13	·14	·14	..
Aberdeen .	·21	·21	·18	·14	·13	·12	·11	·11	·13	·16	·17	·19	

In spite of the fact that, as will be presently shown, the mean level varies as a whole from year to year, and that no correction has been applied here for this variation, yet the aforesaid discrepancies never in Dundee, and only four times in the whole period of 624 months at Aberdeen, exceed ·5 ft. One quarter of them lie between 0 and ·04 ft. at Dundee, and between 0 and ·06 ft. at Aberdeen ; 75 per cent. lie between 0 and ·19 ft. at Dundee between 0 and ·22 ft. at Aberdeen.

The arithmetical mean value of the discrepancy is ·14 ft. at Dundee, ·15 ft. at Aberdeen; and the Median value is ·11 ft. at Dundee, ·12 ft. at Aberdeen. It will be seen that these monthly discrepancies themselves fall into an orderly series, being greatest in the month of February, and falling to a minimum in the month of July (Fig. 4).

The mean monthly discrepancy varies from year to year, as is set forth in the following Table (Table D); and, while there is no obvious regularity in the nature of this variation, it will be seen (especially after the successive annual values are smoothed, in groups of three) that at our two stations the variation is similar and concordant.

TABLE D.—Mean Sea Level. Mean Monthly Discrepancies, in individual Years, from the Monthly Means for the entire period (in fractions of a foot).

	Unsmoothed.		Smoothed Numbers.	
	Dundee.	Aberdeen.	Dundee.	Aberdeen.
1897 . .	·113	·142	..	..
1898 . .	·109	·105	·124	·12
1899 . .	·151	·132	·123	·123
1900 . .	·108	·132	·147	·144
1901 . .	·181	·168	·124	·140
1902 . .	·083	·121	·170	·171
1903 . .	·246	·225	·145	·146
1904 . .	·107	·092	·150	·145
1905 . .	·096	·117	·124	·098
1906 . .	·170	·086	·138	·116
1907 . .	·149	·145	·147	·116
1908 . .	·123	·118	·132	·134
1909 . .	·123	·138	·126	·136
1910 . .	·131	·152	·134	·147
1911 . .	·148	·150	·161	·173
1912 . .	·205	·216	..	·193
1913 . .	..	·213	..	..

For comparison with our results at Dundee and Aberdeen, I obtained some time ago, by the kindness of Admiral Mostyn Field, F.R.S., at that time Hydrographer to the Admiralty, the tide-gauge records at Milford Haven for the years 1886 to 1892. These records were complete, save for a short interruption in the spring of 1891. The mean sea level was determined in the same way as for Dundee, that is to say, not by an integration of the curves, but by a simple comparison of the high and low water levels. The results are briefly set forth in Table VIII. (p. 44).

It will be observed that the results are less regular than are those for Dundee, the mean monthly values giving a more irregular curve; and this is not only due to the shorter period over which the mean values are taken, but also to a greater irregularity, or a greater complexity, of the curves for the individual years. But, nevertheless, the monthly mean values show a curve which in its main features agrees with the Dundee one, showing, that is to say, a spring minimum and a winter maximum, with a total range or amplitude of about ·6 ft. And when we smooth the Milford Curve, by averaging the

monthly figures in consecutive groups of three, we obtain a fairly smooth curve, whose general agreement with the Dundee one is

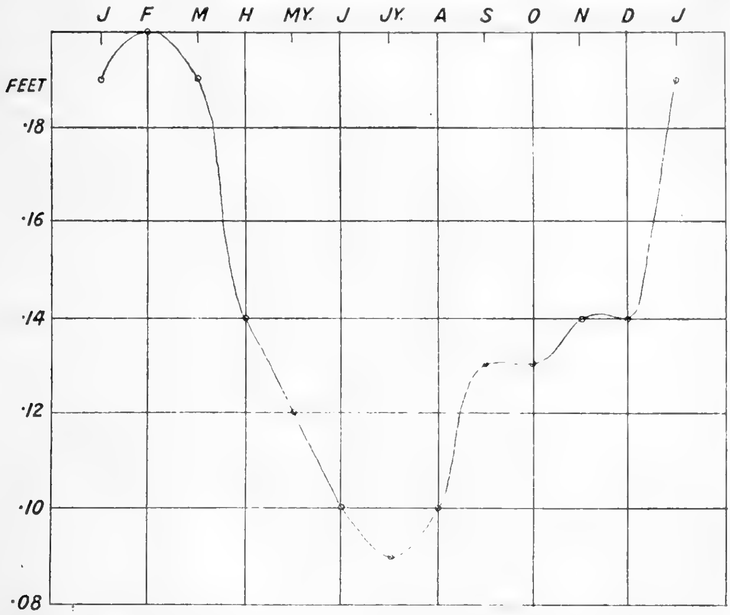

FIG. 4.—Mean discrepancies, in individual months, of Mean Sea Level at Dundee from the Monthly Means for the whole period (1897–1912); smoothed curve.

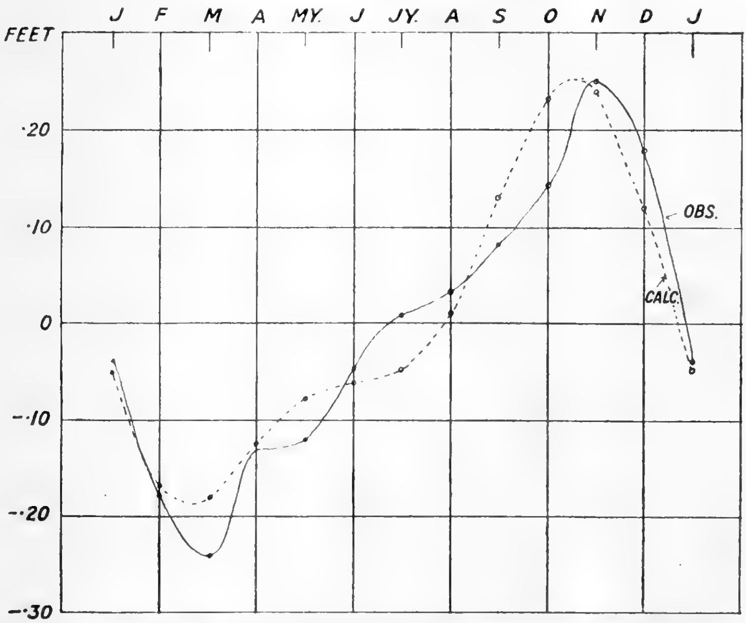

FIG. 5.—Mean Sea Level at Milford Haven, compared with the Mean of the period 1886–1892. (Smoothed curve and calculated do.)

obvious: the chief difference between the two consisting in a greater amplitude at Dundee, and a retardation of phase, which is about one month later than at Milford (Fig. 5.)

The phenomenon we are considering was first detected nearly fifty years ago by Lord Kelvin, who, in discussing the records of the Ramsgate Tide-gauge, said, "I also found very decided indications of an *annual* rise and fall, which seemed to exceed the amount of the solar semi-annual tide, and to make the mean level very sensibly higher in autumn than in spring, an effect probably to be accounted for by an annual period in the amount of water received into the sea by drainage, in the melting of ice, and from the direct fall of rain into it." Mr. Roberts, in an appendix to Lord Kelvin's Report, gives the co-efficients for the two waves as follows (in feet); for the annual tide, ·127 sin (2t+253°), and for the semi-annual tide, ·0748 sin (2t+72°). And Mr. Edward Roberts, who, after half a century, still carries on his father's work of tide-prediction, has most kindly given me the corresponding formulæ for certain other British ports (see p. 14).

In recent years this annual fluctuation has attracted very considerable attention, and accounts of it have been published for various stations, especially in the Baltic and on the German, Dutch, and Norwegian coasts.

The following figure (Fig. 6), taken from a paper by Professor Otto Pettersson, shows, from month to month, the Mean Sea Level at certain stations on the Dutch and Baltic coasts, while similar results have been arrived at in Norway by Professor Geelmuyden. The general correspondence between the curves is very striking, and with their main features our curves for Dundee, Aberdeen, and Milford are in general agreement.

In order to summarise, as briefly as possible, this part of the question, I give the following Table, in which our own results are compared with those given in Professor Krümmel's *Handbuch der Oceanographie,* and with certain others given us more recently by Dr. Brehmer and Dr. Rosen.

TABLE E.—Monthly Mean Sea Level, in feet, above or below the Mean Annual Value.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Aberdeen .	·17	·02	–·12	–·26	–·29	–·22	–·11	–·02	·04	·22	·22	·36
Dundee . .	·22	·03	–·18	–·30	–·36	–·28	–·21	–·03	–·02	·25	·35	·45
Milford . .	–·01	–·37	–·15	–·20	–·05	–·11	·01	·13	–·06	·18	·30	·26
Baltic, Sweden*	–·11	–·04	–·30	–·44	–·45	–·27	·10	·16	·25	·23	·10	·23
Batlic, German*	–·15	–·07	–·15	–·19	–·14	·06	·21	·22	·18	·09	–·05	·00
German and Danish Ports†	·04	·00	–·29	–·27	–·24	–·12	·15	·32	·13	·12	·06	·13
Dutch Coast* .	–·04	–·23	–·19	–·36	–·21	–·14	·07	·17	·21	·34	·03	·26
Sweden‡ . .	–·07	·01	–·25	–·39	–·40	–·22	·14	·21	·30	·28	·14	·28

* From Krümmel, *Handb. der Oceanographie*, 2nd ed., 1907, vol. i., p. 58.

† Mean of observations at fourteen German and Danish ports, from Dr. Brehmer, *Ann. der Hydrographie*, May 1913.

‡ Mean of observations at eight Swedish Stations, from Dr. P. C. Rosen, in *Svenska Hydrogr. Biol. Kommissionens Skrifter*, i., 1902.

In Table IX., at the end of this paper, will be found the details of Dr. Brehmer's important observations on Mean Sea Level at German and Danish Stations.

In the following Table I have worked out cosine formulæ, similar

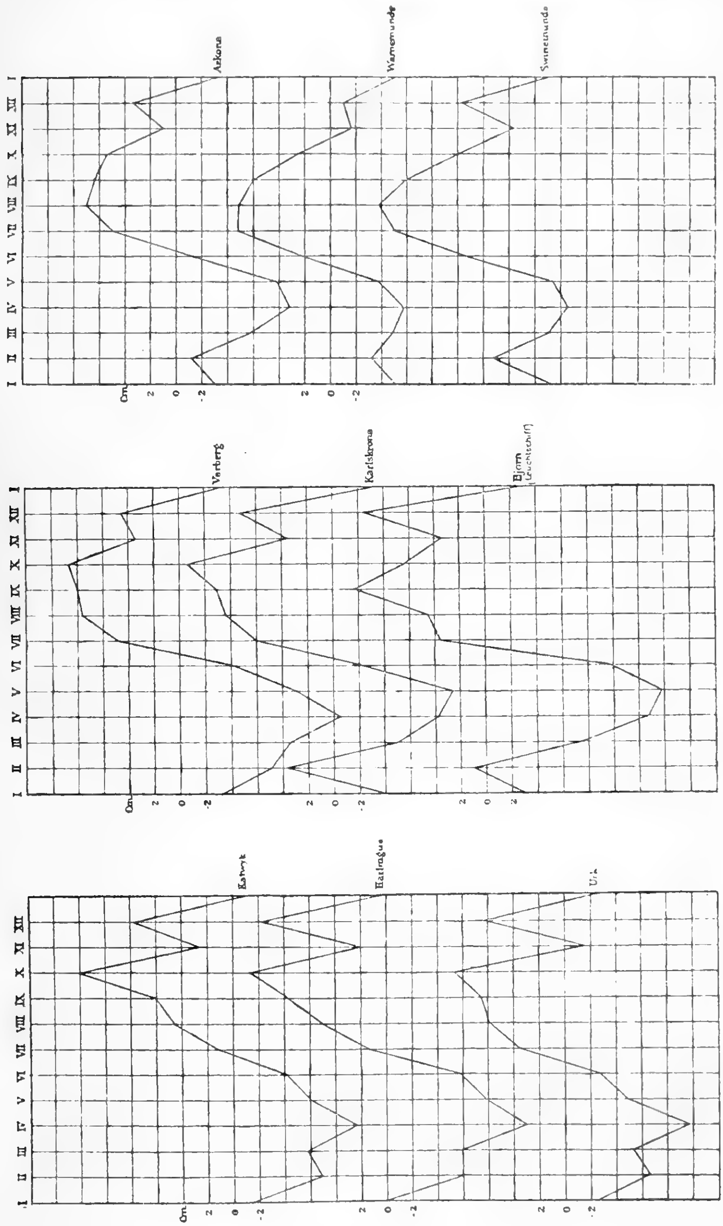

FIG. 6.—Mean Sea Level (in cm.) at Dutch and Baltic Ports: from Professor O. Pettersson, after Rosen.

to those set forth on page 9, for the above data, for certain of the separate Swedish Stations recorded by Dr. P. C. Rosen, and for the German and Danish ports recorded by Dr. Brehmer; and I have

added a number of Professor Geelmuyden's Norwegian results (reduced to feet), and also the various English and Scotch co-efficients which I owe to the kindness of Mr. E. Roberts. We may now use the symbols commonly employed in treatises on the Tides, viz., H for the half-range (or semi-amplitude), and k for the phase-angle, in the annual (Sa) and semi-annual (Ssa) tides, respectively.

TABLE F.—Harmonic Constants for the Annual (Sa) and Semi-annual (Ssa) Tides (in feet; to the epoch of the Sun's mean longitude).

		Sa.		Ssa.	
		H.	k.	H.	k.
Aberdeen	(1862-1913)	·28	237°	·07	189°
Dundee	(1897-1912)	·36	245°	·064	179°
Milford Haven	(1886-1892)	·20	205°	·12	180°
Blackfriars } N. Woolwich }		·32	220°	..	..
Southend		·08	220°	..	..
Dover		·613	271°	..	..
Leith		·466	240°	..	..
Stromness		·444	238°	..	..
Oban		·456	263°	..	..
Liverpool		·362	238°	..	..
Avonmouth		·153	231°	..	..
Dutch ports (mean)		·273	198°	·021	236°
German do. ,,		·180	160°	·074	269°
Swedish do. ,,		·328	207°	·099	273°
Bjorn	(1892-1900)	·335	197°	·115	281°
Karlskrona	(1887-1900)	·295	164°	·082	237°
Ratan	(1892-1900)	·404	214°	082	284°
Varberg	(1887-1900)	·328	190°	·052	253°
Bremerhaven		·190	205°	·126	242°
Esbjerg		·370	232°	·127	233°
Hirstal		·290	240°	·152	233°
Frederikshaven		·287	208°	·124	234°
Aarhuus		·253	197°	·074	231°
Fredericia		·208	198°	·061	243°
Slipshaven		·175	180°	·058	217°
Korsör		·214	181°	·096	260°
Hornboek		·280	185°	·167	244°
Copenhagen		·240	186°	·149	242°
Gjedser		·203	165°	·144	285°
Travemünde		·184	161°	·105	288°
Swinemünde		·200	166°	·174	272°
Memel		·209	163°	·203	272°

These are the constants of cosine formulæ, reduced to the epoch of mean solar longitude, as used by students of tidal phenomena. By our first analysis of a series of twelve monthly mean values, we obtain a formula in such terms as—

$$A_0 + A_1 \cos (t + e_1) + A_2 \cos (2t + e_2),$$

where the phase is reckoned from the epoch of mid-January, say 15th January. For reduction to the epoch of the sun's longitude (h), which may be taken as 295°, or 295 days, before the 15th January, we have merely to substitute ($h-e$) for e in the above formula, which new constant is usually known as k. If we continue to call mean sea level, A_0, our formula then becomes

$$A_0 + H_{s_a} \cos (h - k_1) + H_{s_{sa}} \cos (2\,h - k_2).$$

		Sa.		Ssa.	
		H.	k.	H.	k.
Norwegian Stations—					
Christiania	(1888-89)	·617	183°	·243	156°
,,	(1892-93)	·404	173°	·164	357°
,,	(1885-90)	·423	188°	·167	205°
Oscarborg	(1877-78)	·492	183°	·256	141°
,,	(1884-85)	·423	224°	·220	54°
,,	(1872-82)	·446	173°	·085	254°
Arendal	(1888-89)	·320	204°	·167	184°
,,	(1886-89)	·325	191°	·098	178°
Stavanger	(1889-1900)	·364	222°	·105	112°
,,	(1900-01)	·213	231°	·240	116°
Bergen	(1884-85)	·259	213°	·075	82°
,,	(1893-94)	·276	253°	·194	217°
,,	(1884-89)	·315	210°	·315	210°
Trondhjem	(1872-81)	·446	252°	·220	174°
Bodö	(1896-97)	·285	247°	·059	165°
,,	(1900-01)	·433	243°	·236	213°
Fineide	(1869-97)	·253	216°	·177	182°
,,	(1879-98)	·443	210°	·276	222°
Kabelvaag	(1884-85)	·502	311°	·052	251°
,,	(1889-90)	·512	250°	·344	199°
,,	(1881-85)	·305	255°	·180	214°
Vardö	(1881-82)	·755	270°	·217	247°
,,	(1901-02)	·400	250°	·049	7°
,,	(1881-85)	420	241°	·243	228°

It is difficult, so far as I can see, to draw positive conclusions from an inspection of these data. We observe in the case of the Norwegian Stations, where the values are recorded for different epochs, that the several determinations are often very discrepant; but we may assume, meanwhile, that this is, in part at least, the natural consequence of those variations of still longer period which we shall afterwards discuss. When we set down the various constants on the chart, and attempt to correlate them according to their geographical position, we meet with little success: the contour-lines which come out clearly and easily when we are dealing, for instance, with sea-temperatures, evade us here. But, nevertheless, we seem able to detect some appearance of regularity. The half-amplitude of the annual wave is largest, so far as our data go, at Dover (·613 ft.); it is large (·45 ft. or thereby) at Leith, Oban, Stromness, and at the northern Norwegian stations. It appears to increase (1) as we go northward along the West Coast of Great Britain from the Bristol Channel to Oban; (2) as we come southward along the East Coast of Scotland from Aberdeen to Leith; and (3) as we proceed northward along the Coast of Norway. As we pass from the North Sea round Denmark to the Baltic, it appears to grow smaller: its mean value for four stations from Bremerhaven to Frederikshaven, near the Skaw, is ·28 ft.; at seven stations in the Belts and Cattegat, ·21 ft.; and at three Baltic stations, from Travemunde to Memel, ·20 ft. The median value for all our recorded data is ·32 ft., with half the observed value between ·25 and ·42 ft.; or excluding the Norwegian records, ·28 ft., with half the observed value between ·20 and ·34 ft.

The half-amplitude of the semi-annual wave is, on the average, about one-third that of the annual wave. Its median value is ·12 ft., or excluding the Norwegian stations, ·09 ft.; and one-half the observed values lie between ·07 and ·12 ft. The Norwegian observations are

above the average, but are very discrepant among themselves; those within the Baltic, at Swinemünde and Memel, are also high; those on the west and north of Jutland are higher than those within the Belts, though not higher than at Copenhagen and Gjedser.

As regards the phase-coefficient k, I think that it is possible to trace a tendency to diminution as we pass eastward in the case of the annual wave, and a tendency to increase in the case of the semi-annual wave; that is to say that, as we go eastward, the semi-annual

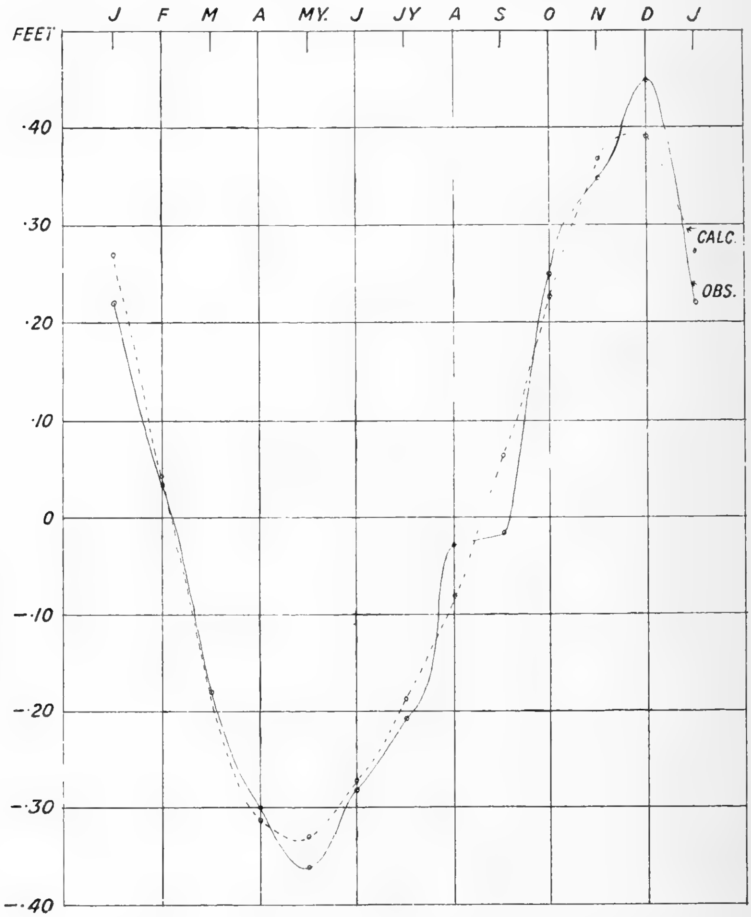

Fig. 7.—Mean Sea Level at Dundee; observed and calculated curves.

wave is accelerated, and the annual wave is retarded. Thus, for instance, in the case of the annual wave, k has a mean value of about 230° at the British stations; 225°, or practically the same, at the Norwegian; 221° at the stations from Bremerhaven to the Skaw; 207° at the Swedish stations; 185° at the seven stations in the Belts and Cattegat; and 160° at the three stations in the Baltic. In the case of the semi-annual wave, k has a mean value of 183° at Aberdeen, Dundee, and Milford Haven: of 182° at the Norwegian stations; of 235° from Bremerhaven to Frederikshaven; of 257° from Aarhuus

to Gjedser ; of 259° at our Swedish ports ; of 277° at our three German ports in the Baltic.

The cosine formulæ of Table F. give, on expansion, a very satisfactory agreement with the observed results ; as is shown, for instance, in the following Table for Dundee (Fig. 7).

Table G.—Mean Monthly Values of Mean Sea Level, compared with the Annual Mean, at Dundee (in feet).

	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Observed .	·22	·03	–·18	–·30	–·36	–·28	–·21	–·03	–·02	·25	·35	·45
Calculated	·27	·04	–·18	–·31	–·33	–·27	–·19	–·08	·06	·23	·37	·39
Difference	·05	·01	·00	·01	–·03	–·01	–·02	–·05	·08	–·02	·02	–·06
Mean High Water.												
Observed .	·07	–·03	–·11	–·17	–·27	–·26	–·19	·09	·09	·29	·26	·25
Calculated	·16	–·03	–·19	–·26	–·24	–·17	–·09	–·01	·09	·20	·28	·27
Difference	·09	–·02	–·08	–·09	–·03	·09	·10	·10	·00	·09	·02	·02
Mean Low Water.												
Observed .	·37	·08	–·24	–·41	–·43	–·28	–·23	–·14	–·12	·23	·46	·65
Calculated	·44	·07	–·28	–·45	–·40	–·29	–·22	–·17	–·04	·21	·50	·61
Difference	·07	–·01	–·04	–·04	·03	–·01	·01	–·03	–·08	–·02	·04	–·04

In all of these cases there are obviously other factors (though small in amount) entering into the composition of the wave, and this is the case in somewhat greater degree in the more irregular curves presented by the foreign stations. But the following example is sufficient to show that a harmonic formula, including only an annual and a semi-annual component, approximates very fairly well to the conditions of the curves at the foreign stations also.

Table H.—Mean Monthly Values of Mean Sea Level, compared with the Annual Mean, at German Baltic Ports. After Krümmel (reduced to feet).

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Observed .	–·15	–·07	–·15	–·19	–·14	·06	·21	·22	·18	·09	–·05	·00
Calculated	–·07	–·10	–·16	–·19	–·11	·04	·22	·24	·19	·07	–·02	–·06
Difference	·08	–·03	–·01	·00	·03	·02	–·01	–·02	–·01	·02	·03	·06

It will be seen that the differences between the observed and calculated values are, as nearly as possible, of equal magnitude in the case of Dundee and of the German observations. It is possible, or even probable, that the differences might be eliminated, in great part if not wholly, by taking into account other harmonic factors of comparatively long period, such as the tides Mf, MSf, and Mm. ; but it is, of course, impossible to investigate these on the basis of our twelve monthly means. In any case they are not of sufficient magnitude to obscure or invalidate the annual and semi-annual waves, which are the main features of the curves.

Of observations upon the annual variation of Mean Sea Level in regions remote from our own seas, I can only quote the case of Aden, which has been frequently dealt with, for instance, by Sir George Darwin,* and by Professor Krümmel.†

TABLE I.—Variation of Mean Sea Level at Aden (in feet).

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
·19	·23	·27	·33	·34	·11	–·21	–·45	–·41	–·31	–·13	·11

Here we have again a very simple curve, which may be approximately expressed (to the epoch of mid-January) as $A + \cdot 376 \cos (t - 62^\circ) + \cdot 111 \cos (2t + 98^\circ)$.

It will be noticed that the phase is nearly the opposite of that which we have been dealing with in British Seas, the maximum being now in spring and the minimum in late summer.

As regards the causation of these annual and semi-annual tides, it is generally held that, as Lord Kelvin said, they are not true tides of astronomical origin, but are due to meteorological causes. The solar tides of annual and semi-annual period are, as Sir George Darwin reminds us,‡ "probably quite insensible as arising from astronomical causes." The annual tide is of quite microscopic minuteness, and even the semi-annual tide, which is many times larger, is very small. Yet we have seen that the actual annual and semi-annual tides are of very considerable magnitude and regularity, and are taken careful account of, wherever possible, in tide-prediction. Whatever the cause of these fluctuations may be, it is commonly stated that it *must* be of terrestrial, or "meteorological" origin. But as to the direct *raison d'être* of these tides, Sir George Darwin, writing to me a few years ago (1906), said: "It seems to me unsafe to speculate as to how far an annual inequality may be due to ice-melting, rainfall, and acceleration of ocean currents. At least I would not hazard a conjecture."

There is little which I can contribute towards the solution of the problem. Let me try, however, to describe, very briefly, the work which has already been done.

Of the meteorological causes which have been suggested in order to account for our phenomena, there are some which seem to have very little or no appreciable significance. Among these I would place rainfall and evaporation, and the effects of frost and thaw. On our East Coast of Scotland, at least, the annual curve of rainfall is very much more irregular than is the curve of sea level which we desire to explain; nor do the periods of maximum and minimum by any means agree. We have still to seek for phenomena which shall explain the great similarity in character of the fluctuations in sea level that we have found in such different regions as Milford and Dundee, the Dutch Coast and the Baltic Stations; regions in which we have very wide variations in climate, in rainfall, in the magnitude of the winter frosts, in the proximity of great rivers, in short in very many of the

* *Scientific Papers*, pp. 300, 301.

† *Op. cit.*, i. p. 62. The data are taken from the *Verhandl. d.* 12 *allg. Konf. d. intern. Erdmessung*, 1898, Stuttgart, p. 379.

‡ *Op. cit.*, vol. i. p. 28.

features to which we should naturally look for a meteorological explanation. The chief meteorological causes which remain to be considered are barometric pressure and wind. That the former has a marked influence on the mean level of the ocean was shown long ago by Sir James C. Ross from observations made on his Antarctic Expedition in 1848. Here Sir James Ross showed that for many consecutive days the Mean Sea Level varied inversely as the height of the barometer, and that the difference of level corresponded to the difference of barometric height approximately in the ratio of the specific gravities of sea-water and of mercury. In short, as Sir James Ross said, his observations seemed to indicate "that the ocean is a water-barometer on a vast scale of magnificence." * Similar observations had already been made by M. Daussy and by Sir John Lubbock (Sen.) in his work on the Tides.

Professor Geelmuyden (*op. cit.* pp. 19, 53) has considered this question in connection with the tides at Christiania. His method was simply to reduce the observed tide-levels to a constant barometric pressure. "A set of barometric readings, registered during the same period, was handed over by the Norwegian Meteorological Institute. On the approximate supposition that the action of air pressure on the water level is instantaneous, they were analysed in exactly the same manner as the tides, and the values of A, B, etc. [the harmonic components] multiplied by 13·25 (which was taken as the specific gravity of mercury as compared with sea-water) were added with their sign to the corresponding tidal constants. The effect on the terms of astronomical origin is mostly insignificant, even on terms whose amplitude is so small that they have been retained only for the purpose of this comparison. But all five tides of long period came out with diminished co-efficients, and three of them with strongly altered phase ; only for the annual tide was the phase sensibly the same, which seems to prove that other meteorological causes, principally, perhaps, prevailing winds, act on the whole in the same direction as the direct air pressure, but stronger still."

If we take, by interpolation, from Dr. Buchan's Meteorological Atlas, the mean monthly barometric heights at Dundee, we find that they follow a mean annual fluctuation which shows a maximum in May, and a minimum in November or December, the total range being from about 757·4 to 750·4 mm.† The curve is not unlike in form to our curve of Mean Sea Level, and is nearly opposite to it in phase. But, on the other hand, when we compare the two curves we see that an amplitude of 3·0 mm. of mercury in the one corresponds to about 244 mm. of water in the other, or one mm. of mercury to over 80 mm. of water. This is just about six times the ratio which Sir James Ross found in the Antarctic,—six times, that is to say, the ratio of the two specific gravities. Moreover, though the phase of the annual

* *Phil. Trans.*, vol. 144, 1854, p. 295.

† The actual monthly means at Dundee for the period 1897–1912, kindly given me (since the above was written) by Dr. A. Watt of the Royal Scottish Meteorological Society, are somewhat different from the above, viz., Jan., 759·3; Feb., 756·4; Mar., 756·6; Apr., 758·4; May, 760·5; June, 760·9; July, 760·6; Aug., 758·2; Sept., 761·6; Oct., 758·4; Nov., 757·8; Dec., 754·6. Here we have high values in September and in January; but there happen to have been some exceptionally high readings in both months in the course of the period of sixteen years.

wave in the two phenomena is not very different, it may easily be seen that the tidal wave *precedes*, by a month or more, the barometric wave.

The direct and local influence of barometric *pressure* is therefore quite inadequate to produce our phenomenon, though it is highly probable, as Professor Geelmuyden believes, that it plays its part therein.

While the direct effect of local barometric pressure is thus inadequate to account for our phenomenon, the effect of wind or of barometric *gradient* would seem to give us greater help. At Aden, for instance, as Sir George Darwin has pointed out, the annual periods of tidal rise and fall very nearly correspond to the periods of the South-West Monsoon, which begins to blow about the end of April, and of the North-West Monsoon, which blows in the winter months. The latter wind blows right into the Gulf of Aden and the former blows directly out; and their effect in heaping up the water in the Gulf, and in withdrawing it again, is undoubted. At the same time, the tidal fluctuation at Aden is seen to possess a pretty large semi-annual component, which is not accounted for by the Monsoon theory. In our own case, we have no similar and equally regular change in the direction of the wind, but we have an increase in force of the prevailing south-west winds in winter, which would at least tend to produce the observed heightening of the Mean Sea Level at that season.

Mr. O. H. Tittman, the Superintendent of the U.S. Coast and Geodetic Survey, a very learned authority on the tides and on all other hydrographic questions, writing to me a few years ago, said that he had no hesitation in attributing the annual inequality to the direction, or to the force, of the prevailing winds. He informed me that on the east coast of the United States, the prevailing wind is westerly and north-westerly during the winter season, and south-westerly or southerly during the summer; and that, in accordance with these facts, the water-level is depressed in the former and raised in the latter season. At Boston, Mass., where the prevailing winds are at all seasons westerly, their greater strength in winter again causes a diminution in the height of the water at that season. In 1895, Mr. W. H. Wheeler (*loc. cit.*) returned to this question and pointed out that "the barometer cannot be made of service in predicting the conditions of the tide, as the pressure varies on different parts of the coast, and in order to calculate its effect on the tide the direction of the *gradient* of pressure and the locality of high and low pressure must first be known." Again, in an important article published in 1897, Mr. F. L. Ortt, discussing the effect of wind on the tides from observations on the Dutch Coast, shows clearly the great part which wind plays in affecting the Mean Sea Level, and gives formulæ by which its effect can be represented both upon the height of Mean Sea Level and on the time of high water.

In our Dundee and Aberdeen observations, we have already seen that the annual fluctuation of mean low water level has a greater amplitude than that of high water or of Mean Sea Level. This phenomenon also Mr. Ortt has observed, and has suggested an explanation of it. He says (*loc. cit.* p. 83) "the value of *a* [that is to say, the correction to be applied in the case of absolute calm] seems rather larger at low water than at high; thus on an average the absolute calm level at low water is 5 cm. lower than the mean low water, and at high water is 2 cm. lower than the normal." He ascribes this

phenomenon simply to the greater effect of the wind in disturbing the comparatively small bulk of water to be moved at low tide than the greater bulk which has to be moved at high.

In the case of Mr. Ortt and Mr. Wheeler's work, they have dealt with the effect of winds and of barometric gradient, as the case may be, upon individual tides, and have not attempted to trace the average periodic fluctuation which may be ascribed to the same cause. Mr. D. la Cour, in a recent paper dealing with Mean Sea Level in Danish waters, has dealt at considerable length with this problem. He shows, on the one hand, that there is a marked correlation between the observed heights, monthly and annual, of Mean Sea Level, and the barometric gradient as determined by a comparison of the barometric heights at the four angles of a quadrilateral extending between Shetland, Calais, Cracow, and the Aland Islands. But after making all due allowance for the barometric variation, the corrected curve of Mean Sea Level is still, very approximately, a sine curve, with a minimum about the month of March and a maximum about the month of August. Its total amplitude (at Frederikshaven) would seem to be, as far as I can judge from Mr. la Cour's curves, about 12 or 13 cm. The correction for barometric gradient, however, has a very marked effect in depressing the water level as a whole; the corrected Mean Sea Level for the year being 11·1 cm. at Frederikshaven, and 19·1 cm. at Esbjerg, below the actual observed mean level. The cause of the under-lying annual tide is still to seek.

There are other points of considerable interest in Mr. la Cour's paper. He shows, for instance, that the mean level of the sea at different places in the Danish Sounds (taking 5-day means) is very closely correlated: in such a way that the difference in level between any two stations can be almost precisely equated with the difference between two others; or, in other words, that the level at three stations being known, that at a fourth can be at once determined. He shows, in the next place, that the difference in level (5-day or monthly means) between two neighbouring stations is very nearly proportional to, and is therefore the chief cause of, the velocity of the surface current in the adjacent channel: with this further refinement, that a given difference of level gives rise to a velocity which differs at different seasons of the year, this difference being apparently due to a diminished internal friction of the water with the rise of temperature in summer. Again, Mr. la Cour has many interesting observations regarding inaccuracies in, and variations in, the levels of the Danish Survey, and he concludes that, both by the study of the currents and the actual levels, something like an annual movement of the earth's surface is capable of detection.

The present paper was already written, and in proof, when I received from General V. H. O. Madsen of Copenhagen an extremely important paper by himself and Lieut. N. M. Petersen on the Mean Sea Level of the Danish Coasts.*

These authors work out, by very careful methods, the harmonic formulæ for the annual variation of Mean Sea Level at the various Danish stations, and arrive at results very similar to those which I have given above. The amplitudes which they find for the various

* De Danske Kysters Middelvandstand. *Den Danske Gradmaaling* (Ny Raekke), Heft Nr. 13. Copenhagen, 1914.

waves are slightly less than those which I have worked out from the figures given by Dr. Brehmer, and this may be due, in part at least, to the preliminary process of smoothing which their figures appear to have undergone.

Thus the mean of their determinations of the half-amplitude of the annual wave at nine stations (excluding Gjedser) is 7·37 cm., while the mean at the same stations, according to my rough calculation, is 7·84 cm.; and in like manner the mean of their values for the semi-annual wave is 2·97 cm., mine being 3·42 cm. The differences are not very large, and the results for the individual stations are entirely consonant. (*See* Table N, p. 30, and Table F, p. 14.)

In the next place, following the lines set forth by Mr. la Cour, they give for the various stations similar formulæ, corrected for the influence of wind: that is to say, reduced to the hypothetical condition of no barometric gradient, or of absolute calm. As will be seen from Table N, while in all cases the amplitude of the wave, both annual and semi-annual, is diminished by this correction, the diminution is not relatively very great, or, in other words, the annual and semi-annual tides remain with their main features unimpaired. While the mean amplitude, uncorrected, of the annual wave at nine stations is 7·37 cm., the corrected value is 6·60 cm., and again the mean value of the semi-annual amplitude is found to be 2·97, which, when corrected, falls to 1·10 cm. It will be noted that the correction produces a much larger effect upon the semi-annual than upon the annual wave.

In Table N, the value A_o is referred to the zero-level of the Danish Geodetic Survey. It will be seen that this value is greatly altered by the correction for wind, the latter factor being found to raise the Mean Sea Level of the Danish Coast in a marked degree. The Mean Sea Level of the nine stations is found to be 0·032 cm. *above* the Survey base; but when corrected for wind, it is no less than 7·84 cm. below it.

Lastly, and again following out a suggestion of Mr. la Cour's, the writers have found it possible to correlate a portion of the fluctuation in Mean Sea Level with the actual variation in latitude caused by the changing position of the earth's axis. There is a small periodic movement of the earth's pole, whose period is about 14 months or more, nearly 431 days; and taking the Mean Sea Level at nine Danish stations for the years 1891–1911, the writers have discovered a small fluctuation of identical period with the polar oscillation.

The harmonic formulæ which they find for these fluctuations are as follows:—

(1) For the 431-day period of Mean Sea Level (l) (in cm.)—

$$a_l^{(m)} = -0{\cdot}009 + 0{\cdot}643 \sin (m\,z - 55^\circ{\cdot}03).$$

(2) For the 431-day period of variation of latitude (p) (in seconds of arc)—

$$a_p^{(m)} = -0{\cdot}009 + 0{\cdot}159 \sin (m\,z - 18^\circ{\cdot}29).$$

It will be seen that, while this fluctuation is of very great theoretical interest, the amplitude of the wave is so small (1·29 cm. or ·042 ft. for the total amplitude) that it still leaves unaccounted for the greater part of the total fluctuation in sea-level.

Small as the amplitude of this fluctuation is, I think that it can also be discovered on our own coasts. The Danish authors have

determined it after applying to their data the correction for wind, and this I am at present unable to do; but there seems no reason why, over a considerable period, the 14-months' oscillation should not be demonstrable without this correction.

Between the dates 1897–1913, I have set down, both for Aberdeen and Dundee, the monthly values of Mean Sea Level in successive series of 14 consecutive months: giving not the actual height according to observation, but the difference between that value and the long period mean for the month in question. Taking 14 such periods in the case of Aberdeen (1897–1913) and 13 in the case of Dundee (1897–1912), I obtain the following mean values, in which a somewhat regular fluctuation is at once obvious.

TABLE J.—Mean Heights of Mean Sea Level, in fourteen consecutive months from January 1897, in feet (differences between observed heights and long-period mean values).

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Aberdeen	−·056	·008	·001	·093	·050	·040	·039	−·086	−·098	−·019	−·066	·013	·006	·113
Dundee .	−·045	−·003	−·003	·101	·055	·075	·078	−·110	−·088	−·054	·034	−·022	−·025	·044
Smoothed in 5's.														
Aberdeen	·014	·031	·019	·039	·044	·027	−·011	−·025	−·046	−·051	−·033	·009	·001	·016
Dundee .	−·006	·019	·021	·045	·061	·040	·013	−·020	−·028	−·048	−·031	−·004	−·003	−·010

The harmonic formulæ corresponding to these 14 equidistant values are as follows, in feet (epoch January 15):

Aberdeen . . $\cdot036+\cdot046 \sin (t+40°)$.
Dundee . . $\cdot033+\cdot034 \sin (t+18°)$.

or in centimetres:

Aberdeen . . $1\cdot10+1\cdot40 \sin (t+40°)$.
Dundee . . $1\cdot00+1\cdot04 \sin (t+18°)$.

It will be seen that the amplitudes, though still very small, are somewhat greater, in fact, about twice as great, as those which the Danish writers have discovered.

In the following diagram (Fig. 7a), I show, for Aberdeen, the smoothed values of Mean Sea Level during the 14-monthly period, together with the sine curve calculated therefrom. It will be seen that the agreement is fairly good; but it must at the same time be remembered that the observed values have been subjected (as also in General Madsen's work) to a considerable process of "smoothing." It seems to me certain that General Madsen has succeeded in demonstrating, and even in measuring, this 14-monthly oscillation as regards Mean Sea Level from his Danish Observations, and I think it probable that, in a preliminary way, I have demonstrated it also for Aberdeen; but if my preliminary work has shown the existence of such a wave, I do not for a moment suppose that it is exact enough to determine its magnitude. We must always remember, as will be pointed out again in a later part of this paper, that the variations of Mean Sea Level are the resultant of a very large number of causes, which unite in producing a fluctuation of very great complexity. The small harmonics, of one period or another, which we can extract from the

very complex wave, or parts thereof, are almost innumerable ; and we must be very careful indeed before we ascribe any one of them to a single definite physical cause. Unless we keep well in mind this latter precaution, we may, so to speak, be doing no more than verifying Fourier's theorem, and demonstrating the fact that any function whatsoever may be expressed in a series of sine waves.

In yet another direction has search been made for a cause which

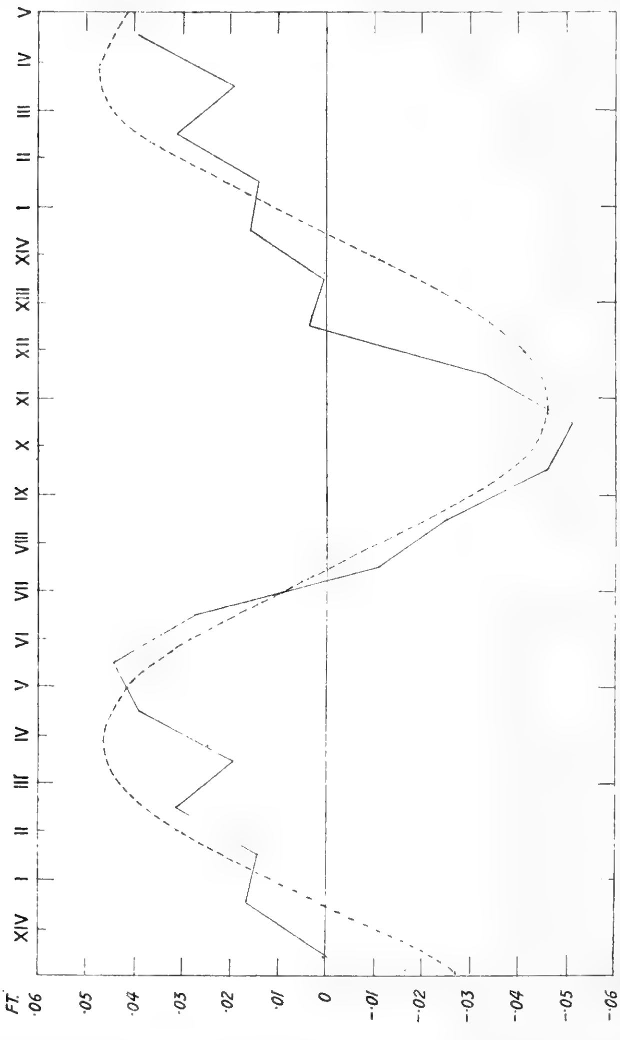

Fig. 7a.—Apparent 14-monthly oscillation of Mean Sea Level at Aberdeen. Monthly means derived from fourteen successive periods of 14 months each, commencing January 1897 ; and sine-curve calculated therefrom.

should account for our phenomenon. Professor Otto Pettersson has turned from local meteorological conditions, in order to seek a cause in a variation of the great oceanic currents and especially of the "Gulf Stream," and to correlate these in turn with long-period astronomical phenomenon. We have some knowledge * of a seasonal

* Cf. Cleve, Ekmann, and Pettersson, *Les variations annuelles de l'eau de surface de l'ocean Atlantique.* Goteborg, 1901.

change in the distribution of salinity on the surface of the Atlantic, due to a greater extension northward and eastward of the warm currents in autumn as compared with spring. But our actual knowledge of the variations of the ocean currents is even now extremely scanty; and, in trying to correlate them with the variations in sea level of which we have been speaking, we are very apt to argue in a circle, and to use these variations of level as a proof rather than as a consequence of the existence of variations in the great ocean currents. Again, since the foregoing pages were in proof, I have received from Professor Otto Pettersson two important papers,* in which this subject is discussed in connection with many other periodic phenomena which

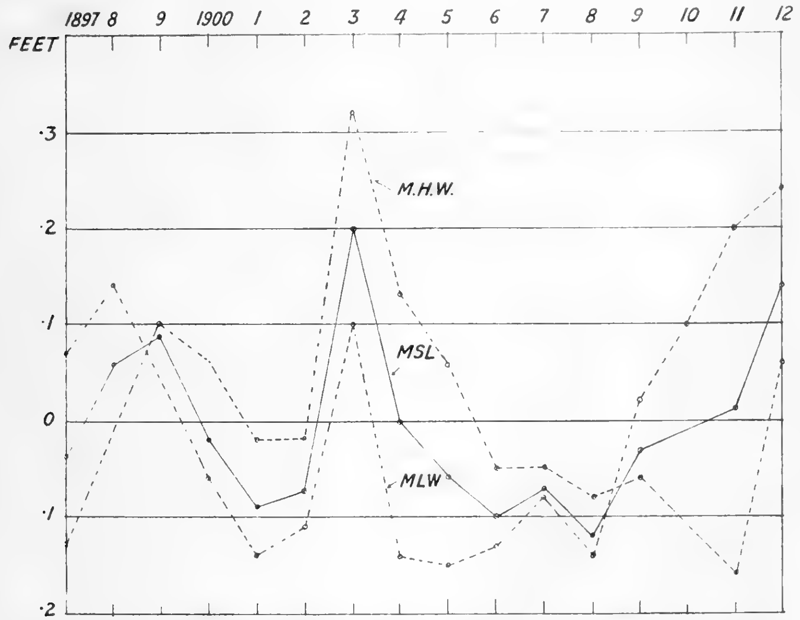

Fig. 8.—Annual Means of High Water, Low Water, and Mean Sea Level at Dundee (1897–1912).

may have their effect on the temperature of the sea and the climate of the earth. It is impossible to do more here than to call attention to these papers.

II. The Variation of Mean Sea Level from Year to Year.

Let us now, returning to Tables I. and IV. (pp. 37, 39), consider the variation of Mean Sea Level from year to year. It will be seen that both at Aberdeen and Dundee the differences are striking in amount, and are not destitute of an appearance of regularity.

Let us consider in the first place the comparatively brief period, of sixteen years, covered by the Dundee observations. It will be

* (1) On the Occurrence of Lunar Periods in Solar Activity and the Climate of the Earth; and (2) Climatic Variations in Historic and Prehistoric Times. *Sv. Hydrogr.-Biolog. Kommissionens Skrifter.* Häft V., 1914.

seen that, at Dundee, the highest annual mean is found in the year 1903, when the Mean Sea Level (*i.e.* the mean of the twelve monthly Mid-tidal values) was ·20 ft. above the general mean for the whole period of 16 years. It fell nearly steadily to a minimum of −·12 ft. in 1908, and then rose again and stood in 1912 at +·14 ft. The general features of the fluctuation are clearly seen from the annexed figure (Fig. 8).

The general trend of the fluctuation at Aberdeen is strikingly similar to that at Dundee (Fig. 9). We have here also maxima in 1903 and 1912. But the amplitude of the fluctuation is, on the whole, a little less at Aberdeen than at Dundee. The 1903 maximum stands ·13 ft. above the mean (instead of ·20 ft.) and the 1908 minimum stands ·06 ft. below the mean (instead of ·12 ft.). The 1912 maximum, however, is a little higher at Aberdeen than at Dundee, viz., ·20 ft., as against ·14 ft.

We have hitherto had little information that would enable us to compare the fluctuations of Mean Sea Level at different stations over a long period; but Dr. Brehmer's recent paper now gives us the means of doing this, for a period of ten years, for a number of German and Danish ports in the North Sea and Baltic, and Dr. Rosen's paper lets us compare the values at certain Swedish Stations with our own for another and earlier period of 14 years.

TABLE K.—Mean Annual Values of Mean Sea Level, at German and Danish Ports, 1900–1909. (Difference from mean of whole period, in cm.). From Brehmer, *Ann. d. Hydrographie*, 1913.

	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
Bremerhaven	−2·1	−2·4	−3·3	7·6	0·3	1·2	3·5	−1·5	−3·6	0·1
Esbjerg	−1·7	−5·1	−4·5	9·3	0·1	−0·4	2·8	0·9	−3·1	1·3
Hirsthals	−0·3	−3·6	−2·1	5·5	−1·6	0·5	1·2	0·1	−2·3	1·9
Frederikshaven	0·2	−4·1	−1·4	5·6	−1·8	0·8	1·9	0·6	−2·6	1·5
Aarhus	−1·7	−3·9	1·3	5·4	−1·2	1·2	2·3	−0·7	−2·0	−0·1
Fredericia	−0·5	−3·3	−0·8	5·8	−1·2	0·9	0·1	−1·1	−2·0	1·7
Slipshaven	−0·5	−3·7	−1·4	5·6	−1·0	2·1	2·1	−0·4	−3·2	0·2
Korsör	−1·4	−3·2	−0·9	6·1	−0·7	1·8	1·7	0·1	−3·6	0·5
Hornboek	−1·8	−4·6	−0·9	6·4	−0·2	2·0	2·3	0·9	−4·1	−0·6
Copenhagen	−1·3	−3·3	−1·1	6·4	−1·7	1·8	2·2	0·0	−4·0	0·4
Gjedser	0·6	−3·2	−1·1	7·7	−2·2	1·9	1·3	0·0	−3·8	−1·2
Travemünde	−0·8	−4·2	−2·0	5·9	−2·3	3·5	2·6	−0·2	−3·3	0·0
Swinemünde	−2·1	−5·0	−1·4	8·6	−1·9	3·5	2·8	0·3	−4·1	−0·8
Memel	−4·0	−7·0	−0·2	12·0	−2·7	5·2	4·5	−1·4	−4·3	−2·0
Mean	−1·24	−4·04	−1·41	7·00	−1·30	+1·86	+2·24	−0·17	−3·29	+0·21
Aberdeen*	0·49	−3·54	−2·56	4·45	0·49	1·40	−0·12	−0·42	−1·34	1·10
Dundee*	0·55	−1·58	−0·98	7·25	1·16	−0·67	−1·89	−0·98	−2·50	0·24

* Reduced to mean of period 1900–1909.

The above Table, which is based on those given by Dr. Brehmer, shows the fluctuations of annual Mean Sea Level about the mean of the whole period of ten years at these ports. It will be seen that the results at all the fourteen stations are very concordant, and the high level in 1903 is especially remarkable at every one of the stations.

Now, if we take the mean of these values, and compare them with the values for (Fig. 10) Aberdeen or Dundee, after adjusting these latter to the mean of the same ten years, we see a striking corre-

spondence. Except for the year 1906 (where a secondary maximum is apparent in the foreign data but not in those for Aberdeen) the two curves run close and parallel. The main phenomenon is evidently a nearly uniform one over the area, or great part of the area, of the North Sea and Baltic.

As far as I can judge, however, from the data given by Dr. Brehmer,

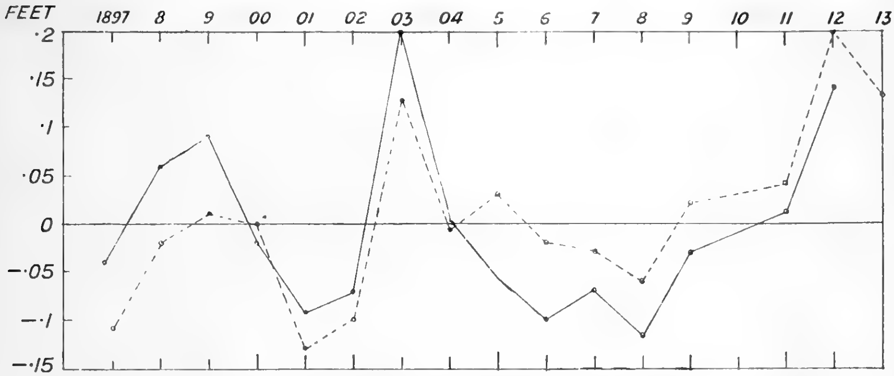

Fig. 9.—Annual Mean Sea Level at Dundee and Aberdeen (1897–1913). (Dotted line, Aberdeen.)

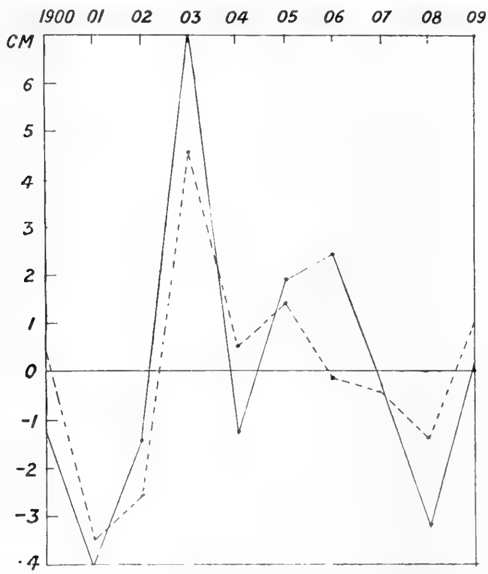

Fig. 10.—Annual Mean Heights (compared with the mean of the whole period) of Mean Sea Level at German and Danish Ports, and at Aberdeen (dotted line) (1900–1909).

the same close comparison would not hold for the Dutch ports. Here the highest values of mean annual sea level would seem to have been reached in 1905, 1906. It is quite possible that another influence entered in those years by way of the English Channel, which did not

affect the East Coast of Scotland, but which had a marked effect upon the Dutch Coast; and which had, further, a sufficient influence upon the German and Danish Stations to produce the discrepancy in those years that has just been mentioned.

An earlier series of observations, for the years 1887–1897, for six German Baltic ports is given by Dr. A. Westphal, and to these Krümmel

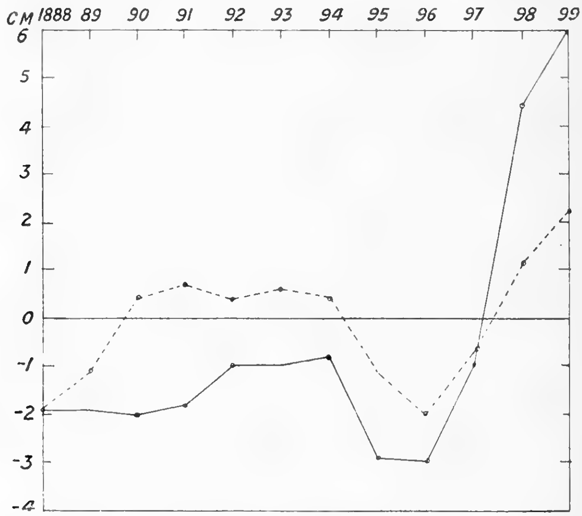

Fig. 11.—Annual Mean Heights of Mean Sea Level (compared with the mean of the whole period) at Swedish Ports (dotted line) and at Aberdeen (1888–1909).

adds the data from Kiel for 1887–1900. For these latter years we have also data from eight Swedish Stations, furnished us by Dr. P. G. Rosen. The curve which these data (Table L.) give us is an irregular one, and its most conspicuous feature is a high maximum in the year 1899, in which all the curves (and all the separate Swedish Stations) agree.

Table L.—Mean Sea Level at Swedish and German Ports, for comparison with that at Aberdeen for the years 1887–1900. Difference (in cm.) from mean of the period 1887–1900.

	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
Swedish Ports .	0·5	–4·2	0·8	1·1	–4·9	–2·2	3·3	0·0	–·15	–3·0	–5·3	4·9	11·7	–1·7
German Baltic do.	–0·2	–2·6	–0·2	1·8	–2·3	–0·3	3·8	–0·4	2·4	0·0	–2·0	..	..	..
Kiel . .	–2·4	–2·2	– ·9	0·5	–2·6	0·0	1·1	–1·7	2·1	–0·5	–0·3	2·7	6·8	– ·5
Aberdeen* .	–0·4	–3·2	–2·0	2·0	1·1	–1·1	1·1	1·7	–1·7	–3·2	–1·0	1·7	2·6	2·3
The same smoothed.														
Swedish Ports .	..	–1·1	–0·8	–1·0	–2·0	–1·3	0·4	1·0	–1·2	–2·8	–1·1	3·5	5·0	..
German Baltic do.	..	–1·0	–0·3	–0·2	–0·3	0·4	1·0	1·9	0·7	0·1	..	..	..	..
Kiel . .	..	–1·8	–0·9	–1·0	–0·7	–0·5	–0·2	–0·5	0·0	–0·5	–0·3	2·2	3·0	..
Aberdeen .	..	–1·9	–1·1	0·4	0·7	0·4	0·6	0·4	–1·1	–2·0	–0·8	1·1	2·2	..

* Reduced to the mean of 1887–1900.

When we look at our Aberdeen records for the same years, no such maximum for the year 1899 is at first sight apparent: but when we observe that the values for the whole period in question are low, and when we reduce them to the mean of the said period (instead of to the mean of the long period 1862–1913) then we find that a maximum in 1899 is well marked. And when we smooth all the curves, including that for Aberdeen, then we see without difficulty that their general trend is very similar (Fig. 11).

From General Madsen's paper, which, as already mentioned, has reached me while this paper of mine is passing through the press, I have compiled the mean annual heights of Mean Sea Level at Copenhagen, for the years 1890–1911; and these are shown in the following Table (Table M.), with and without General Madsen's correction for wind.

TABLE M.—Mean Sea Level at Copenhagen (in cm.), 1890–1911, compared with the mean for the whole period of twenty-two years: (1) uncorrected, (2) corrected for variations of barometric gradient.

	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
Uncorrected . .	1·0	–2·0	–1·8	1·9	–1·5	–0·1	–1·4	–1·3	4·3	8·5	–2·0
Corrected . . .	0·4	–3·3	–0·8	1·1	–2·1	2·0	–0·8	–1·7	2·9	7·5	–0·8
Aberdeen . . .	0·6	–0·3	–2·4	–0·3	0·3	–3·1	–4·6	–2·4	0·3	1·2	0·9
	1901	**1902**	**1903**	**1904**	**1905**	**1906**	**1907**	**1908**	**1909**	**1910**	**1911**
Uncorrected . .	–3·9	–1·7	5·6	–2·4	0·9	1·5	–0·7	–4·5	–0·3	0·6	2·8
Corrected . . .	–1·9	–1·9	2·7	–3·8	–0·1	0·7	–0·5	–3·6	–0·3	–0·2	2·7
Aberdeen . . .	–3·1	–2·1	4·9	0·9	1·8	0·3	0·0	–0·9	1·5	1·8	2·1

It will be seen that the high maximum in 1899, already noted from Kiel and the Swedish stations, is here very conspicuous. It is of very considerable interest to see that the correction for wind, or rather for barometric gradient, has but a small effect upon the *annual* mean values of Mean Sea Level; this fact is clearly brought out by the annual values (Table M.) which I have deduced from General Madsen's Tables of Monthly Means. On the average, the amplitude of the fluctuation is a little diminished by this correction; that is to say, the mean departure from zero-level, irrespective of sign, in twenty-two years, is 2·3 cm. in the uncorrected, and 1·9 cm. in the corrected values. But the two series of values run from 1890 to 1911 in very close conformity. Wind, or barometric gradient, is certainly not a direct and potent cause of the variation *from year to year* of Mean Sea Level. If we compare the Aberdeen values (reduced to the mean of the same period) with those for Copenhagen, we again see a general trend of similarity, in spite of the absence at Aberdeen of the high maximum in 1899, characteristic of Copenhagen and the other Baltic stations. It is a curious fact that from 1890 to 1899 the Copenhagen annual means are almost all above the Aberdeen values, but are almost all below these from 1900 to 1911.

TABLE N.—Harmonic Formulæ for Annual Variation of Mean Sea Level at Danish Ports, from Madsen and Petersen, 1914 (in cm. referred to zero-level of Danish Geodetic Survey, epoch January 15).

I. Uncorrected. II. Corrected for influence of Wind.

$$a^{(m)} = A_o + A_1 \cos(m\,z - e) + A_2 \cos(m(2z) - e_2).$$

		A_o		A1		e1		A2		e2	
		I	II	I	II	I	II	I	II	I	II
Esbjerg . . .	1889–1911	5·31	– 8·91	10·54	6·21	291°	236°	3·58	2·07	22°	230°
Hirstal . . .	1892–1911	–4·40	–14·67	8·65	7·68	268°	223°	3·60	1·08	12°	293°
Frederikshaven .	1893–1911	–3·55	–11·53	8·26	7·24	270°	234°	3·32	1·41	6°	303°
Aarhuus . . .	1888–1911	–2·02	– 6·35	6·96	5·87	271°	249°	1·81	0·58	12°	300°
Fredericia . .	1889–1911	–1·11	– 3·15	5·68	5·19	264°	253°	1·12	0·38	34°	36°
Slipshaven . .	1896–1911	–0·40	– 4·35	5·61	5·62	256°	234°	2·57	1·04	36°	47°
Korsor . . .	1897–1911	3·25	– 0·30	5·56	5·53	256°	233°	2·58	1·39	39°	54°
Hornboek . .	1898–1911	1·49	– 8·62	7·83	8·93	255°	212°	4·49	0·88	16°	11°
Copenhagen . .	1889–1911	1·82	– 4·91	7·19	7·13	254°	221°	3·66	1·04	35°	41°
Gjedser . . .	1898–1911	2·60	..	4·95	..	234°	..	3·92	..	57°	..
Denmark . . .	1888–1911	0·21	..	7·03	..	266°	..	2·88	..	26°	..

Lastly, we may attempt to compare the fluctuations at Milford Haven (1886–1892) with those at Aberdeen. Here again there is,

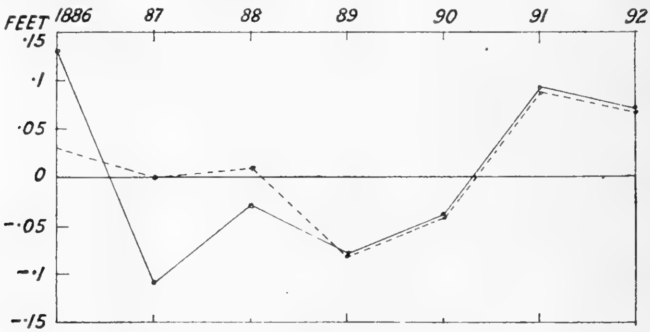

FIG. 12.—Mean Sea Level at Milford Haven: annual deviation from the mean of 1886–1892. The dotted line represents the same data for Aberdeen, but for the years 1885–1891.

at first sight, but little correlation. But if we imagine the Aberdeen curve to be retarded a year in comparison with the Milford Haven one, and compare the Milford Haven level in 1887 with that of Aberdeen in 1886, and so on, then we find a curiously close agreement between the two superimposed curves (Fig. 12). I do not think, however, that the period available for comparison is long enough to let us give very much weight meanwhile to this remarkable apparent correspondence.

To sum up, it is clear that the apparent fluctuations from year to year in Mean Sea Level (as here defined) are not merely local phenomena, but are similar in separate and distant localities. The similarity between Dundee and Aberdeen (1897–1912) is close. The similarity between these and the German and Danish Stations (1900–1909), as given by Brehmer, is again close, though there are certain notable differences, especially in the years 1905–1906. There is again a resemblance, in the most salient features of the curve, for the years 1887–1900, between the observations at Kiel and those at our Scottish

Stations. The Swedish results (1887–1900), though somewhat irregular, can be shown to resemble those of the Scottish Stations at least in their most conspicuous features and their general trend. While, lastly, the Milford Haven results (1886–1892) can also, apparently, be correlated with the Scottish, if we allow for one year's retardation of phase.

Having arrived, then, at the conclusion that the apparent variation in Mean Sea Level from year to year is not a mere local

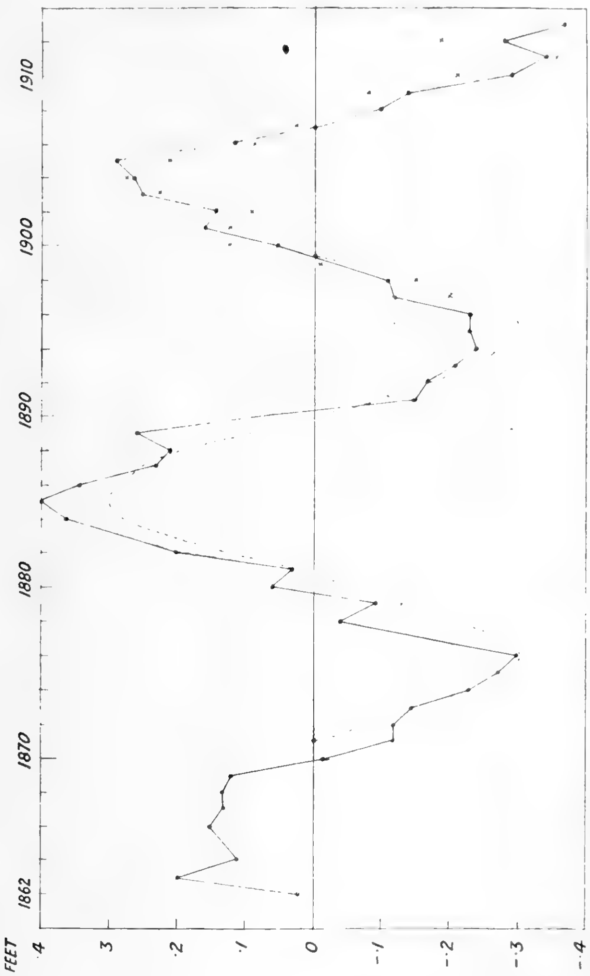

Fig. 13.—Mean Annual Intertidal Range at Aberdeen (1862–1913), showing 19-year period. The Values for Dundee are shown by small crosses from 1897–1912.

phenomenon, but is common, in greater or less detail, to widely separated stations, let us look more closely at the longest set of available data, viz., those for Aberdeen, in order to see whether the variation shows signs of any regular periodicity.

Let us begin by examining, not the Mean Sea Level, but the *Intertidal Range*,—the mean difference between Mean High Water and Low. We have not dealt hitherto with the fluctuation in this quantity from month to month, for, as we might of course expect,

and as we see from Table VII., it shows us a semi-annual wave, whose maxima correspond to the spring tides of spring and autumn.

When we deal with it over a long period of years, we see at once that it varies with very remarkable regularity. As will be seen from Table VII. and Fig. 13, the Mean Annual Intertidal Range varies in very close approximation to a sine curve, having a total amplitude of about 0·7 ft., with maxima in or about the years 1866, 1885, 1904. This is in precise correspondence with the variation in the moon's inclination to the ecliptic, which, in its period of 18½ years, has its minima at these identical epochs. Of the three maxima shown by our curve, that of 1866 is considerably the lowest, and that of 1885 is the highest of the three. If, for the purpose of eliminating this 19-year tide, we smooth the annual readings in successive groups

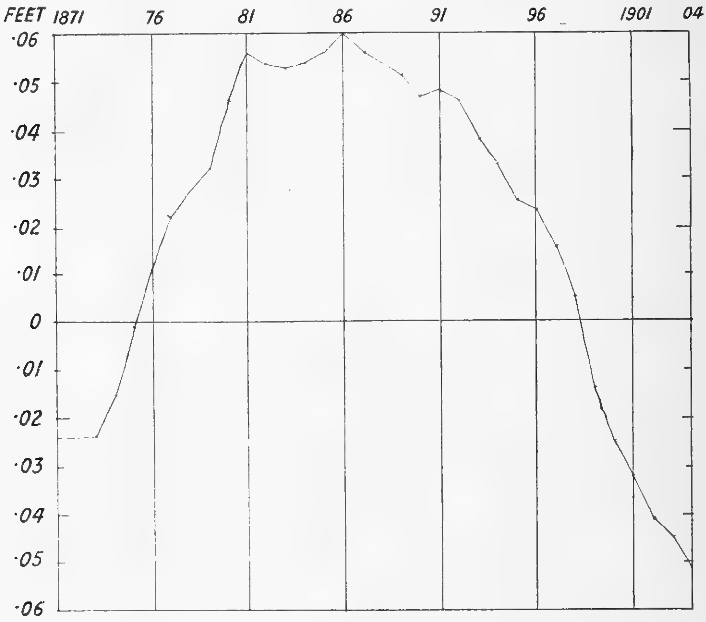

Fig. 14.—The Mean Intertidal Range at Aberdeen, after elimination of the 19-year wave by smoothing in successive groups of 19 years.

of 19 years, we find that there remains a residual tide of very long period, so long that the whole extent of our observations does not give us a complete wave (Fig. 14). The maximum of this wave lies somewhere about 1886, that is to say, it approximately coincides with one of the 18½-year maxima. The total fall, from 1886 to 1904, in which year the curve is still a descending one, is just over ·11 ft., or say 3·3 cm. The form of the curve suggests that its period is somewhere about 50 years. In spite of the very small amplitude of this fluctuation, it will be seen that the successive points of the curve come out with very great regularity. I have no hypothesis to offer as to the cause of this phenomenon.

The 19-year tide is equally well-marked in our records from Dundee, as will be seen from the following Table :—

TABLE O.—Interval between Mean High and Low Water Levels (in feet) at Dundee.

	1897	1898	1899	1900	1901	1902	1903	1904	
Intertidal Range	11·60	11·65	11·79	11·92	11·92	11·89	12·02	12·07	
Difference from mean	−·20	−·15	−·01	·12	·12	·09	·22	·27	
	1905	**1906**	**1907**	**1908**	**1909**	**1910**	**1911**	**1912**	**Mean**
Intertidal Range	12·01	11·88	11·82	11·86	11·72	11·59	11·44	11·62	11·80
Difference from mean	·21	·08	·02	·06	−·08	−·21	−·36	−·18	

Just as in the case of Aberdeen, we see that the largest interval was in 1904, and that the height of this interval fell away in a nearly regular curve from this year of maximum to the beginning of our series in 1897, and again towards the end. The whole period of 19 years is not represented; but the amplitude within the years available is about 0·63 ft., which agrees very well with the total amplitude which we have found at Aberdeen, viz., 0·70 ft.

While the curve for the Intertidal Range is a very smooth one, the curves for Mean High and Mean Low Water, from which it is derived, are not nearly so smooth. On the contrary, they both show minor undulations, which to a large extent cancel one another out when the one set are subtracted from the other. In the main, the curves for Mean High and Mean Low Water are each made up of a succession of sine curves, corresponding to the 19-year period, but they apparently contain other secondary harmonics which I have not elucidated.

When smoothed in successive periods of 19 years, the values both for Mean High and Mean Low Water show a long-period curve, descending from the beginning of the period, and again ascending towards its end. But the two curves differ in amplitude and apparently also in phase. The amplitude of the Mean High Water curve, so far as it goes, *i.e.* from 1871 to the minimum about 1893, is about ·10 ft.; that of the Mean Low Water curve, in the same period, is about ·19 ft. Owing to the fact that both curves are incomplete, showing only part of an entire vibration, it is impossible to determine the phase even approximately; but it looks as though the minimum were somewhat later in the case of Mean High Water than for Mean Low Water.

Returning now to the curve of Mean Sea Level, it is obvious that it must show a long period fluctuation, similar to those of Mean High and Mean Low Water. This fluctuation is illustrated in Fig 15. From 1871 (which is the middle of our first group of 19 years) the Mean Sea Level falls away, on the whole smoothly, till 1893, and again rises till 1904 (which again is the middle of our last group of 19 years). The difference of level between 1871 and 1893 amounts to just about ·15 ft. or 1·8 in., or, say, 4·5 cm. Small as the amplitude of this fluctuation is, and spread over some 22 years, it is remarkable how clearly and regularly it is brought out by the observations at hand.

On the other hand, the 19-year (or, rather, 18·6 year) tide, which follows the regression of the modes of the moon's orbit, and which we have just seen to appear so plainly in our curves for the mean inter-tidal range, is not to be detected in our values of Mean Sea Level. As Darwin has shown,* the amplitude of this tide must be very small. Its total range amounts to about ·12 of a foot at the poles, and about half of that amount at the equator. About latitude 35° it vanishes altogether, and in the latitude of Aberdeen (57°) its total amplitude should be about the same as at the equator, viz., ·06 ft., or say, 1·8 cm.; that is to say the average change of level from one year to

Fig. 15.—Values of Mean Sea Level at Aberdeen after smoothing in successive groups of 19 years.

another, due to this tide, is only about ·006 ft., or less than 0·2 cm. It is not surprising that so small a fluctuation should fail to manifest itself, masked as it evidently is by many and much larger perturbations.

I have tried to explore, by various "periodogram" methods, our series of values of Mean Sea Level, in the hope of discovering other long-period fluctuations, but as yet with very little, or no, success, save perhaps for the 14-monthly period already alluded to.

I have some reason to suspect a small fluctuation having a period

* *Scientific Papers*, vol. i. pp. 116, 371, 1907.

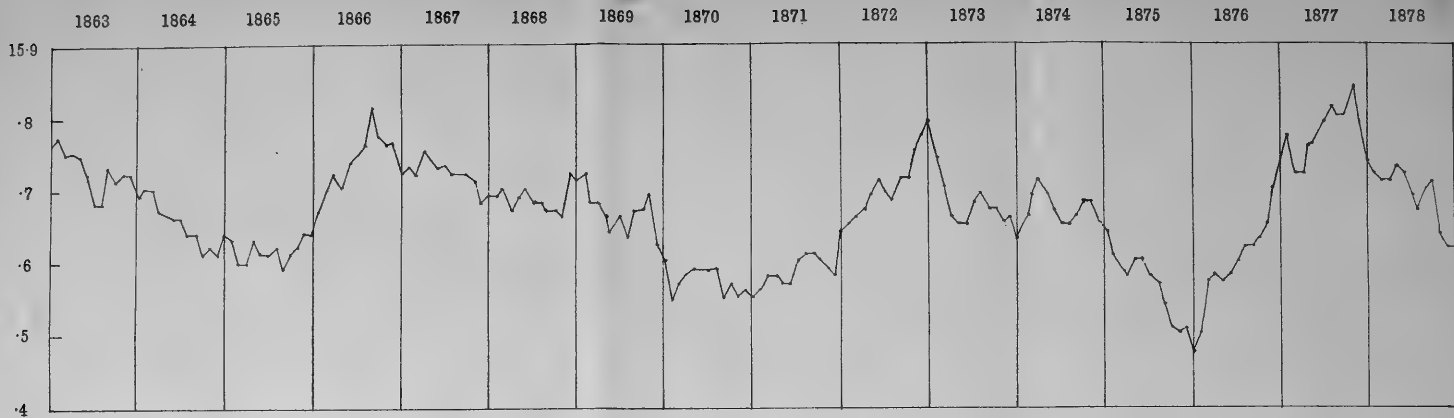

Fig. 16.

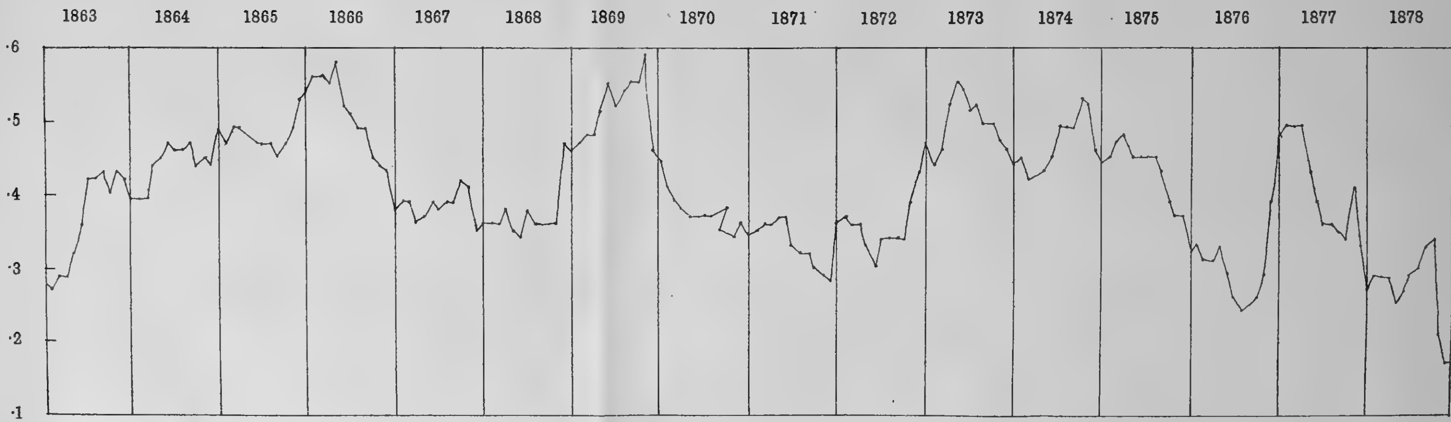

Fig. 17.

Wt 3389-28 750 11/14 M'F. & E.

of about $4\frac{1}{2}$ years, and a total amplitude of about 0·08 ft., or ·24 cm.; but even this is far from clear.

Among other methods, I have used one given by Professor H. H. Turner.* By this method we may easily carry the Fourier analysis through a long series of numbers, for instance, our series of monthly values of Mean Sea Level; and in doing so, we may obtain, for each consecutive, and overlapping, series of twelve months, the mean (A_0) the amplitude (A_1), and the phase (ε), of the annual fluctuation. Now, if there happens to be a single well-marked periodicity, and this corresponds with the period selected (in this case twelve months), then the values of A_1 and ε will remain nearly constant. If there be a single well-marked periodicity, but of a period greater or less than 12 months, then the values will increase or decrease steadily. And lastly, if there be more than one periodicity, but all the periodicities are of a permanent character, then there will be "interferences" which will cause the values to follow a wavy, but more or less regular, line. Now the last of these is very clearly what happens in our case (Figs. 16, 17). All three values—mean, amplitude, and phase—fluctuate in a recurring series of waves; for two or three consecutive waves we may seem to see an equality of period, but this apparent equality disappears, giving place to waves of gradually changing amplitude and period. This is a sure sign of the presence of complicated interference phenomena.

Now, whatever be the causes of our phenomenon, we may be quite sure that, in the aggregate, they are very complex. Meteorological influences, possibly rainfall and more certainly barometric gradient, undoubtedly enter in; changes in the great ocean currents (whatever these changes may in turn be due to) in all probability play their part; the minute oscillations of the earth's axis produce a noticeable and measurable effect; and even the long-period astronomical tides, small as is the magnitude of their influence, must not be wholly left out of account. But besides all these we must bear in mind two other important conditions: (1) the existence of interference phenomena, or "beats," resulting from the interference of ordinary well-known tides of moderate period; and (2) the possibility, or rather probability, that a part of the apparent phenomenon is spurious, and due to our selection of a certain artificial period (calendar month and calendar year) for the determination of our means. It is obvious that in the simplest harmonic series we should get an *apparent* slow change of mean if we took our data from portions only of the wave; and it is equally obvious that in the complex tidal effect no single period that we may choose for the determination of our average values will keep us clear of this more or less fallacious result.

In short, what with the actual and little understood causes which perturb the mean level of the sea, and what on the other hand with the difficulties which attend its determination even though nothing more than the complex tidal wave were present to disturb it, it is quite plain that the determination of Mean Sea Level is an extremely difficult thing, and one which cannot by any possible means be achieved in any brief period of time. I do not see how it is ever to be deter-

* "On a simple method of detecting discontinuities in a series of recorded observations, with an application to Sunspots." Papers of the I.U.S.R. Computing Bureau, No. XIII. 1913. (Monthly Notices of the R.A.S., Dec. 1913).

mined except by integration of the entire record of an automatic tide gauge over a very long period of time; and even after very many years, we should only have approached, but not attained to, a rigorous determination.

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TABLE I.—Mean Sea Level at Dundee, 1897–1912 (in feet above the sill of Earl Grey Dock; Ordnance Datum=9·74 feet on gauge).

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean
1897 . .	10·28	10·27	10·34	10·11	10·08	10·15	10·28	10·46	10·42	10·50	10·57	10·77	10·35
1898 . .	10·66	10·52	10·10	10·21	10·21	10·15	10·11	10·32	10·45	10·86	10·72	11·04	10·45
1899 . .	10·892	10·60	10·245	10·32	10·00	10·14	10·17	10·34	10·70	10·67	11·10	10·56	10·48
1900 . .	10·59	10·53	9·96	9·93	10·12	10·13	10·28	10·24	10·30	10·81	10·92	10·81	10·37
1901 . .	10·70	9·87	10·07	10·20	9·76	10·17	10·04	10·21	10·65	10·66	10·66	10·62	10·30
1902 . .	10·63	10·23	10·27	10·05	9·88	9·98	10·14	10·15	10·26	10·62	10·76	10·85	10·32
1903 . .	10·88	10·88	10·80	10·27	10·13	9·99	10·37	10·59	10·58	11·09	10·75	10·74	10·59
1904 . .	10·60	10·67	10·16	10·26	10·14	10·02	10·26	10·33	10·41	10·56	10·51	10·74	10·39
1905 . .	10·615	10·23	10·295	10·165	9·79	10·14	10·185	10·385	10·43	10·355	10·715	10·705	10·33
1906 . .	10·805	10·16	10·19	9·73	10·01	9·93	10·025	10·54	10·10	10·69	10·785	10·52	10·29
1907 . .	10·12	10·20	9·955	10·13	10·145	10·35	10·075	10·365	10·285	10·72	10·615	10·89	10·32
1908 . .	10·60	10·09	9·90	9·81	9·985	9·99	10·125	10·29	10·395	10·46	10·78	10·82	10·27
1909 . .	10·60	10·29	10·395	10·21	9·92	9·95	10·235	10·315	10·08	10·83	10·605	10·885	10·36
1910 . .	10·80	10·725	10·01	10·045	10·00	10·17	10·26	10·33	10·19	10·33	10·70	10·94	10·38
1911 . .	10·26	10·47	10·06	10·21	10·15	10·23	10·08	10·39	10·48	10·47	10·90	11·14	10·40
1912 . .	10·65	11·00	10·59	9·89	10·23	10·31	10·16	10·51	10·26	10·69	10·77	11·34	10·53
Mean . .	10·61	10·42	10·21	10·09	10·03	10·11	10·18	10·36	10·37	10·64	10·74	10·84	10·39
Height above Ordnance Datum .	0·87	0·68	0·47	0·35	0·29	0·37	0·44	0·62	0·63	0·90	1·00	1·10	0·65
Difference from Annual Mean	0·22	0·03	0·18	–·30	–0·36	–0·28	–0·21	–0·03	–0·02	0·25	0·35	0·45	—

Table II.—Mean High Water at Dundee, 1897–1912.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean
1897	15·95	15·97	16·29	15·92	15·86	15·87	16·07	16·58	16·43	16·28	16·23	16·25	16·15
1898	16·37	16·35	15·78	16·05	16·11	16·00	15·85	16·36	16·46	16·82	16·42	16·65	16·27
1899	16·66	16·61	16·19	16·35	16·00	16·20	16·15	16·18	16·60	16·54	16·86	16·24	16·38
1900	16·45	16·36	16·16	16·11	16·23	16·06	16·22	16·27	16·21	16·77	16·97	16·30	16·34
1901	16·51	15·72	16·05	16·27	15·73	16·04	15·96	16·37	16·70	16·76	16·52	16·48	16·26
1902	16·44	16·15	16·14	16·01	15·83	16·03	16·15	16·03	16·37	16·62	16·66	16·67	16·26
1903	16·69	16·77	16·96	16·43	16·26	16·06	16·53	16·66	16·58	17·00	16·64	16·56	16·60
1904	16·50	16·59	16·35	16·46	16·31	15·95	16·27	16·50	16·40	16·52	16·46	16·61	16·41
1905	16·39	16·15	16·24	16·24	15·85	16·09	16·17	16·55	16·65	16·52	16·67	16·54	16·34
1906	16·65	16·07	16·10	15·64	15·94	15·92	15·99	16·78	16·18	16·73	16·62	16·18	16·23
1907	15·79	15·98	16·08	16·23	16·23	16·38	16·09	16·28	16·21	16·48	16·34	16·68	16·23
1908	16·39	16·07	15·89	15·94	16·12	15·87	15·97	16·24	16·45	16·41	16·59	16·46	16·20
1909	16·23	16·20	16·16	16·15	15·78	15·78	16·09	16·27	16·09	16·94	16·34	16·58	16·22
1910	16·43	16·55	15·85	15·89	15·81	15·97	16·08	16·25	16·06	16·20	16·36	16·59	16·17
1911	15·77	16·07	15·92	16·13	16·09	15·93	15·93	16·15	16·27	15·99	16·52	16·71	16·12
1912	16·38	16·78	16·51	15·89	16·04	16·12	15·96	16·48	16·22	16·53	16·26	16·91	16·34
Mean	16·35	16·27	16·17	16·11	16·01	16·02	16·09	16·37	16·37	16·57	16·54	16·53	16·28

Table III.—Mean Low Water at Dundee, 1897–1912.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean
1897	4·60	4·56	4·39	4·29	4·29	4·42	4·49	4·34	4·41	4·71	4·90	5·19	4·55
1898	4·95	4·69	4·41	4·36	4·31	4·30	4·36	4·275	4·445	4·89	5·01	5·43	4·62
1899	5·125	4·59	4·30	4·29	4·00	4·09	4·19	4·50	4·81	4·81	5·34	4·89	4·59
1900	4·72	4·70	3·76	3·74	4·00	4·20	4·33	4·21	4·39	4·84	4·87	5·31	4·42
1901	4·89	4·02	4·08	4·12	3·79	4·29	4·12	4·04	4·60	4·56	4·79	4·75	4·34
1902	4·82	4·30	4·40	4·08	3·93	3·92	4·13	4·26	4·15	4·62	4·86	5·02	4·37
1903	5·07	4·98	4·63	4·11	3·99	3·91	4·21	4·51	4·57	5·18	4·85	4·91	4·58
1904	4·69	4·74	3·97	4·06	3·97	4·08	4·24	4·15	4·22	4·59	4·55	4·86	4·34
1905	4·84	4·31	4·35	4·09	3·73	4·19	4·20	4·22	4·21	4·19	4·76	4·87	4·33
1906	4·96	4·25	4·28	3·82	4·08	3·94	4·06	4·30	4·02	4·65	4·95	4·86	4·35
1907	4·45	4·42	3·83	4·03	4·06	4·32	4·06	4·45	4·36	4·96	4·89	5·10	4·41
1908	4·81	4·11	3·91	3·68	3·85	4·11	4·28	4·34	4·34	4·51	4·97	5·18	4·34
1909	4·97	4·38	4·63	4·27	4·06	4·12	4·38	4·36	4·07	4·72	4·87	5·19	4·50
1910	5·17	4·90	4·17	4·20	4·19	4·37	4·44	4·40	4·31	4·46	5·03	5·29	4·58
1911	4·74	4·89	4·20	4·28	4·21	4·53	4·23	4·63	4·68	4·95	5·28	5·56	4·68
1912	4·91	5·21	4·66	3·88	4·42	4·49	4·36	4·54	4·30	4·85	5·29	5·76	4·72
Mean	4·86	4·57	4·25	4·08	4·06	4·21	4·26	4·35	4·37	4·72	4·95	5·14	4·48

TABLE IV.—Mean Sea Level at Aberdeen, 1862–1913 (in feet above the sill of Victoria Dock; Ordnance Datum=14·62 feet on gauge).

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1862	15·91	15·66	15·60	15·48	15·46	15·75	15·74	15·62	15·39	16·27	15·83	16·20	15·74
1863	16·12	15·74	15·46	15·48	15·25	15·50	15·32	15·63	15·93	16·03	15·99	16·18	15·72
1864	15·82	15·77	15·55	15·12	15·14	15·41	15·40	15·40	15·85	15·74	16·09	16·03	15·61
1865	16·21	15·62	15·19	15·15	15·51	15·09	15·47	15·49	15·51	15·97	16·18	16·27	15·64
1866	16·27	15·98	15·54	15·39	15·30	15·43	15·52	15·77	16·06	15·53	16·10	16·25	15·76
1867	15·83	16·06	15·45	15·65	15·24	15·30	15·55	15·61	15·75	15·86	15·95	15·92	15·68
1868	15·94	16·07	15·57	15·30	15·48	15·40	15·32	15·63	15·57	15·88	15·80	16·65	15·72
1869	15·90	16·19	15·06	15·28	15·26	15·20	15·45	15·35	16·05	15·82	16·07	15·84	15·62
1870	15·68	15·54	15·35	15·37	15·34	15·23	15·40	15·34	15·58	16·06	15·87	16·01	15·56
1871	15·48	15·66	15·60	15·34	15·22	15·23	15·68	15·59	15·58	15·97	15·77	15·89	15·58
1872	16·16	15·82	15·70	15·48	15·42	15·41	15·49	15·51	15·87	15·97	16·27	16·10	15·76
1873	16·40	15·29	15·14	15·06	15·25	15·46	15·83	15·65	15·67	15·95	15·97	16·24	15·66
1874	16·11	15·60	15·45	15·37	14·99	15·25	15·50	15·65	15·90	16·18	15·95	15·83	15·65
1875	15·96	15·25	15·22	15·26*	15·21*	15·28*	15·33	15·45	15·60	15·84	15·83	15·87	15·51
1876	15·47	15·70	15·99	15·39	15·04	15·47	15·59	15·62	15·67	15·97	16·04	16·40	15·70
1877	16·21	15·81	15·46	15·37	15·47	15·69	15·78	15·91	15·54	15·94	16·45	15·90	15·79
1878	15·53	15·58	15·42	15·33	15·69	15·57	15·46	15·64	15·90	16·05	15·64	15·61	15·62
1879	15·58	15·62	15·36	15·55	15·21	15·72	15·70	15·76	15·74	15·61	15·55	15·84	15·60
1880	15·52	15·96	15·28	15·41	15·16	15·36	15·47	15·45	15·68	15·61	16·07	16·00	15·58
1881	15·49	15·19	15·50	15·29	15·26	15·95	15·64	15·88	15·61	15·86	16·40	15·98	15·67
1882	15·68	15·70	15·81	15·29	15·34	15·47	15·70	15·54	15·59	15·83	16·01	15·86	15·65
1883	15·88	15·76	15·23	15·27	15·38	15·29	15·58	15·57	15·67	15·85	16·09	15·72	15·61
1884	15·92	15·71	15·47	15·30	15·36	15·23	15·39	15·54	15·59	15·71	15·58	15·94	15·56
1885	15·51	16·00	15·16	15·27	15·54	15·30	15·24	15·37	15·79	15·70	15·74	15·79	15·53
1886	15·58	15·06	15·39	15·19	15·21	15·37	15·55	15·53	15·69	15·76	15·84	15·83	15·50
1887	15·74	15·44	15·34	15·19	15·21	15·22	15·61	15·60	15·61	15·60	15·74	15·79	15·51
1888	15·48	14·92	15·21	15·10	15·24	15·16	15·50	15·55	15·28	15·56	16·01	15·99	15·42
1889	15·48	15·26	15·39	15·49	15·27	15·24	15·32	15·69	15·50	15·64	15·65	15·65	15·46
1890	16·24	15·09	15·70	15·43	15·38	15·45	15·57	15·51	15·59	15·82	15·78	15·47	15·59
1891	15·52	15·20	15·55	15·06	15·24	15·14	15·44	15·68	15·91	16·06	15·85	16·06	15·56
1892	15·72	15·36	15·27	15·17	15·34	15·35	15·33	15·56	15·66	15·74	15·76	15·64	15·49
1893	15·47	15·83	15·53	15·07	15·27	15·31	15·39	15·55	15·81	15·91	15·68	15·88	15·56
1894	15·89	15·71	15·49	15·34	15·20	15·32	15·53	15·54	15·28	15·57	16·12	16·01	15·58
1895	15·20	15·17	15·52	15·38	15·01	15·16	15·53	15·62	15·57	15·75	15·86	15·88	15·47
1896	15·46	15·32	15·52	15·20	14·93	15·31	15·37	15·29	15·78	15·53	15·51	15·85	15·42
1897	15·35	15·50	15·51	15·24	15·34	15·29	15·43	15·67	15·54	15·55	15·70	15·80	15·49
1898	15·85	15·70	15·33	15·43	15·41	15·27	15·33	15·54	15·52	15·81	15·71	16·11	15·58
1899	15·88	15·75	15·45	15·54	15·24	15·25	15·45	15·45	15·84	15·78	16·12	15·63	15·61
1900	15·67	15·80	15·11	15·33	15·46	15·39	15·52	15·49	15·53	15·87	15·76	16·33	15·60
1901	15·83	15·10	15·32	15·51	14·99	15·28	15·21	15·47	15·71	15·74	15·69	15·81	15·47
1902	15·77	15·35	15·55	15·28	15·21	15·19	15·40	15·45	15·40	15·67	15·84	15·91	15·50
1903	15·52	16·17	16·04	15·51	15·37	15·16	15·59	15·82	15·66	16·19	15·93	15·81	15·73
1904	15·82	15·77	15·30	15·60	15·35	15·40	15·49	15·58	15·45	15·72	15·73	15·91	15·60
1905	15·81	15·75	15·35	15·64	15·52	15·46	15·49	15·64	15·66	15·56	15·82	15·83	15·63
1906	15·76	15·64	15·47	15·41	15·14	15·36	15·50	15·59	15·36	15·94	15·99	15·74	15·58
1907	15·41	15·50	15·24	15·38	15·41	15·66	15·36	15·71	15·53	15·88	15·75	15·98	15·57
1908	15·88	15·49	15·15	15·06	15·42	15·33	15·38	15·60	15·65	15·68	16·00	15·89	15·54
1909	15·83	15·47	15·54	15·53	15·27	15·24	15·69	15·64	15·32	16·12	15·85	15·99	15·62
1910	16·05	15·97	15·31	15·41	15·39	15·44	15·51	15·57	15·38	15·52	15·88	16·09	15·63
1911	15·48	15·75	15·29	15·51	15·42	15·48	15·44	15·64	15·77	15·62	16·03	16·25	15·64
1912	15·86	16·18	15·93	15·25	15·53	15·71	15·49	15·80	15·60	15·95	15·90	16·39	15·80
1913	15·93	15·69	16·01	15·55	15·54	15·56	15·46	15·48	15·50	15·99	16·60	15·93	15·77
Mean	15·77	15·62	15·45	15·34	15·31	15·38	15·49	15·58	15·64	15·82	15·91	15·96	15·60

Table V.—Mean High Water at Aberdeen, 1862–1913.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1862	20·44	20·18	20·25	20·05	20·02	20·25	20·42	20·39	20·18	20·77	20·38	20·62	20·33
1863	20·66	20·39	20·03	20·10	19·95	20·11	20·10	20·52	20·68	20·70	20·41	20·59	20·44
1864	20·24	20·32	20·17	19·88	19·84	20·16	20·13	20·15	20·56	20·37	20·58	20·53	20·24
1865	20·85	20·19	19·90	19·90	20·10	19·76	20·14	20·18	20·26	20·65	20·73	20·67	20·28
1866	20·91	20·52	20·22	20·06	19·98	20·07	20·24	20·57	20·87	20·24	20·66	20·65	20·41
1867	20·34	20·83	19·99	20·33	19·98	19·98	20·31	20·46	20·53	20·52	20·33	20·29	20·32
1868	20·47	20·70	20·16	20·10	10·16	19·98	19·94	20·33	20·36	20·68	20·28	21·13	20·36
1869	20·59	20·83	19·94	19·97	19·88	19·76	19·98	19·93	20·73	20·50	20·68	20·36	20·26
1870	20·22	20·30	20·04	19·98	19·94	19·78	20·00	20·12	20·32	20·55	20·25	20·10	20·13
1871	19·74	20·09	20·05	19·94	19·81	19·82	20·31	20·31	20·30	20·58	20·13	20·19	20·10
1872	20·49	20·28	20·27	20·08	20·00	20·00	20·00	20·02	20·49	20·56	20·73	20·47	20·28
1873	20·92	19·73	19·90	19·68	19·78	19·88	20·10	20·20	20·33	20·50	20·36	20·50	20·16
1874	20·52	20·04	20·01	20·02	19·55	19·67	19·98	20·34	20·60	20·63	20·13	19·79	20·11
1875	20·24	19·75	19·50	19·76*	19·64*	19·67*	19·77	20·04	20·22	20·43	20·19	20·24	19·95*
1876	19·86	20·22	20·33	19·86	19·44	19·87	19·91	20·08	20·23	20·49	20·37	20·65	20·11
1877	20·73	20·28	20·22	19·93	19·84	20·01	20·25	20·30	20·16	20·47	20·92	20·21	20·28
1878	19·96	20·13	20·05	19·84	20·11	19·94	20·07	20·52	20·67	20·62	20·09	20·08	20·17
1879	19·87	20·30	19·83	20·09	19·71	20·21	20·23	20·41	20·47	20·29	20·05	20·25	20·14
1880	20·07	20·63	20·04	20·08	19·75	19·94	19·95	19·96	20·35	20·27	20·63	20·58	20·19
1881	20·22	19·75	20·31	19·95	19·77	20·02	20·26	20·60	20·33	20·42	21·07	20·46	20·26
1882	20·22	20·38	20·43	19·98	19·95	20·10	20·44	20·62	20·46	20·57	20·57	20·27	20·33
1883	20·42	20·49	19·85	20·00	20·09	20·06	20·35	20·41	20·53	20·62	20·73	20·33	20·32
1884	20·66	20·49	20·40	20·10	20·09	19·95	20·09	20·20	20·35	20·51	20·33	20·69	20·32
1885	20·38	20·75	20·11	20·07	20·22	19·95	19·97	20·21	20·63	20·46	20·48	20·46	20·31
1886	20·21	19·76	20·09	19·93	19·94	20·06	20·34	20·52	20·59	20·60	20·52	20·43	20·25
1887	20·29	20·22	19·94	19·86	19·79	19·96	20·30	20·33	20·43	20·47	20·45	20·39	20·20
1888	20·18	19·70	20·12	19·91	19·91	19·74	20·05	20·10	19·98	20·24	20·65	20·67	20·10
1889	20·17	19·92	20·20	20·50	19·91	19·81	19·91	20·47	20·29	20·40	20·28	20·17	20·17
1890	20·71	19·76	20·17	20·00	19·99	20·00	20·15	20·27	20·57	20·59	20·26	19·85	20·19
1891	19·94	19·75	20·19	19·61	19·73	19·65	19·88	20·19	20·45	20·66	20·31	20·41	20·06
1892	20·16	19·76	20·02	19·80	19·79	19·72	19·75	20·02	20·20	20·21	20·27	20·10	19·98
1893	19·88	20·28	20·18	19·64	19·72	19·59	19·83	20·14	20·44	20·43	20·09	20·17	20·03
1894	20·20	20·26	19·82	19·81	19·59	19·66	19·98	20·18	19·95	20·24	20·51	20·32	20·04
1895	19·57	19·65	20·06	19·85	19·41	19·59	19·97	20·11	20·11	20·29	20·32	20·24	19·93
1896	19·92	19·82	20·28	19·78	19·30	19·70	19·72	19·72	20·22	19·91	19·98	20·28	19·88
1897	19·81	20·03	20·15	19·79	19·72	19·63	19·91	20·39	20·29	20·12	20·10	20·20	20·01
1898	20·27	20·24	19·67	19·93	19·84	19·78	19·84	20·25	20·26	20·46	20·20	20·55	20·11
1899	20·41	20·32	20·13	20·10	19·80	19·85	20·00	20·04	20·50	20·32	20·62	20·05	20·18
1900	20·25	20·20	19·99	20·02	20·08	19·85	20·09	20·15	20·24	20·44	20·35	20·84	20·21
1901	20·36	19·84	19·97	20·13	19·55	19·86	19·80	20·25	20·52	20·55	20·35	20·40	20·13
1902	20·44	20·06	20·12	19·87	19·72	19·87	20·06	20·18	20·19	20·42	20·42	20·41	20·15
1903	20·56	20·78	20·75	20·25	20·09	19·93	20·35	20·48	20·35	20·73	20·57	20·38	20·43
1904	20·42	20·43	20·18	20·42	20·12	20·07	20·15	20·30	20·18	20·42	20·37	20·54	20·30
1905	20·33	20·36	20·20	20·46	20·28	20·18	20·09	20·44	20·50	20·43	20·53	20·42	20·35
1906	20·37	20·17	20·18	20·10	19·80	19·92	20·10	20·29	20·10	20·66	20·57	20·24	20·21
1907	19·93	20·03	19·89	20·09	20·10	20·25	20·01	20·26	20·08	20·38	20·23	20·44	20·14
1908	20·33	19·97	19·82	19·73	20·00	19·77	19·82	20·17	20·24	20·22	20·46	20·31	20·07
1909	20·23	20·09	19·98	20·05	19·68	19·61	20·10	20·26	20·03	20·87	20·33	20·37	20·13
1910	20·33	20·38	19·75	19·84	19·77	19·88	19·97	20·05	19·95	20·06	20·33	20·36	20·06
1911	19·78	20·04	19·90	20·02	19·94	19·89	19·91	20·09	20·22	19·88	20·37	20·53	20·05
1912	20·17	20·58	20·44	19·83	19·99	19·99	19·85	20·36	20·16	20·48	20·24	20·76	20·24
1913	20·24	20·17	20·25	19·97	19·85	19·86	19·73	19·95	20·13	20·63	20·92	20·20	20·16
Mean	20·28	20·19	20·08	19·98	19·87	19·90	20·05	20·25	20·34	20·45	20·42	20·39	20·18

TABLE VI.—Mean Low Water at Aberdeen, 1862–1903.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1862	11·39	11·14	10·96	10·92	10·90	11·25	11·06	10·86	10·61	11·78	11·28	11·78	11·16
1863	11·59	11·09	10·91	10·87	10·55	10·89	10·55	10·75	11·18	11·37	11·58	11·78	11·09
1864	11·40	11·23	10·93	10·37	10·45	10·67	10·67	10·66	11·14	11·11	11·61	11·53	10·98
1865	11·57	11·06	10·49	10·41	10·93	10·42	10·80	10·81	10·76	11·29	11·63	11·87	11·00
1866	11·64	11·45	10·86	10·72	10·63	10·79	10·81	10·97	11·25	10·82	11·55	11·85	11·11
1867	11·32	11·30	10·92	10·98	10·51	10·63	10·79	10·76	10·97	11·20	11·58	11·55	11·04
1868	11·41	11·44	10·90	10·51	10·81	10·83	10·71	10·93	10·79	11·09	11·32	12·18	11·08
1869	11·21	11·56	10·18	10·60	10·65	10·64	10·93	10·78	11·37	11·14	11·47	11·33	10·99
1870	11·15	10·78	10·67	10·77	10·75	10·69	10·81	10·57	10·85	11·57	11·50	11·93	11·00
1871	11·23	11·23	11·16	10·74	10·64	10·64	11·06	10·87	10·87	11·36	11·42	11·60	11·07
1872	11·83	11·36	11·13	10·89	10·85	10·83	10·99	11·00	11·25	11·38	11·81	11·74	11·25
1873	11·88	10·85	10·38	10·44	10·73	11·05	11·56	11·10	11·02	11·40	11·58	11·99	11·16
1874	11·70	11·16	10·89	10·73	10·43	10·84	11·02	10·97	11·20	11·73	11·77	11·88	11·19
1875	11·69	10·76	10·95	10·76*	10·79*	10·90*	10·89	10·86	10·98	11·25	11·47	11·51	11·07
1876	11·09	11·20	11·36	10·93	10·65	11·08	11·28	11·16	11·12	11·45	11·71	12·15	11·26
1877	11·69	11·35	10·71	10·82	11·11	11·38	11·31	11·25	10·93	11·42	11·99	11·60	11·30
1878	11·11	11·04	10·79	10·82	11·27	11·20	10·86	10·77	11·13	11·48	11·20	11·15	11·06
1879	11·30	10·95	10·90	11·01	10·72	11·24	11·18	11·12	11·01	10·94	11·06	11·44	11·07
1880	10·97	11·29	10·53	10·74	10·58	10·78	10·99	10·94	11·01	10·96	11·52	11·43	10·98
1881	10·77	10·64	10·69	10·63	10·75	11·89	11·02	11·16	10·89	11·31	11·73	11·51	11·08
1882	11·14	11·02	11·20	10·61	10·74	10·85	10·96	10·46	10·73	11·10	11·45	11·46	10·98
1883	11·34	11·03	10·62	10·54	10·68	10·52	10·81	10·73	10·81	11·09	11·46	11·11	10·89
1884	11·19	10·93	10·54	10·50	10·63	10·51	10·70	10·89	10·84	10·92	10·84	11·19	10·81
1885	10·64	11·26	10·21	10·47	10·86	10·65	10·52	10·54	10·95	10·95	11·00	11·13	10·76
1886	10·95	10·36	10·70	10·45	10·49	10·69	10·77	10·55	10·80	10·93	11·17	11·24	10·76
1887	11·20	10·67	10·74	10·52	10·63	10·48	10·92	10·87	10·80	10·74	11·04	11·20	10·82
1888	10·79	10·15	10·31	10·30	10·58	10·58	10·96	11·00	10·59	10·89	11·38	11·31	10·74
1889	10·79	10·60	10·58	10·47	10·63	10·67	10·72	10·92	10·72	10·89	11·02	11·14	10·76
1890	11·77	10·43	11·24	10·87	10·77	10·90	10·99	10·75	10·62	11·06	11·31	11·09	10·98
1891	11·10	10·66	10·92	10·52	10·75	10·64	11·01	11·18	11·38	11·47	11·40	11·71	11·06
1892	11·28	10·97	10·52	10·54	10·89	10·98	10·91	11·10	11·13	11·27	11·25	11·19	11·00
1893	11·07	11·38	10·89	10·50	10·82	11·03	10·95	10·97	11·19	11·40	11·28	11·60	11·09
1894	11·58	11·17	11·16	10·87	10·82	10·98	11·09	10·90	10·61	10·90	11·73	11·71	11·13
1895	10·84	10·69	10·99	10·92	10·61	10·74	11·09	11·13	11·03	11·22	11·40	11·53	11·13
1896	11·00	10·83	10·77	10·63	10·57	10·93	11·03	10·86	11·34	11·15	11·04	11·42	10·96
1897	10·90	10·98	10·87	10·70	10·97	10·96	10·96	10·95	10·80	10·99	11·30	11·41	10·98
1898	11·45	11·17	11·00	10·94	10·99	10·76	10·83	10·84	10·79	11·17	11·23	11·68	11·07
1899	11·36	11·18	10·77	10·98	10·68	10·65	10·90	10·86	11·19	11·25	11·62	11·22	11·05
1900	11·10	11·40	10·23	10·65	10·84	10·93	10·95	10·84	10·83	11·30	11·18	11·83	11·01
1901	11·31	10·37	10·67	10·89	10·43	10·71	10·63	10·70	10·90	10·93	11·04	11·22	10·82
1902	11·10	10·64	10·99	10·69	10·71	10·51	10·74	10·73	10·62	10·93	11·26	11·42	10·86
1903	0·49	11·56	11·33	10·78	10·65	10·39	10·83	10·16	10·97	11·66	11·29	11·25	11·03
1904	11·22	11·11	10·43	10·78	10·59	10·73	10·83	10·86	10·72	11·03	11·09	11·28	10·89
1905	11·29	11·15	10·50	10·82	10·76	10·75	10·89	10·85	10·83	10·70	11·11	11·24	10·91
1906	11·15	11·11	10·77	10·73	10·49	10·80	10·90	10·89	10·63	11·22	11·42	11·25	10·95
1907	10·90	10·98	10·59	10·67	10·73	11·07	10·72	11·16	10·98	11·38	11·27	11·52	11·00
1908	11·44	11·01	10·49	10·40	10·85	10·89	10·95	11·04	11·07	11·15	11·54	11·47	11·02
1909	11·44	10·86	11·10	11·05	10·86	10·88	11·28	11·02	10·62	11·37	11·37	11·62	11·12
1910	11·77	11·57	10·87	10·99	11·01	11·00	11·06	11·09	10·81	10·98	11·43	11·82	11·20
1911	11·19	11·46	10·69	11·00	10·90	11·07	10·98	11·19	11·32	11·36	11·69	11·98	11·24
1912	11·56	11·79	11·42	10·67	11·08	11·43	11·13	11·25	11·05	11·43	11·57	12·03	11·37
1913	11·63	11·21	11·77	11·13	11·24	11·26	11·19	11·01	10·87	11·36	12·28	11·66	11·38
Mean	11·27	11·05	10·83	10·71	10·75	10·86	10·93	10·91	10·94	11·20	11·41	11·53	11·03

TABLE VII.—Range of Tide, or interval between Mean High

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
1862	9·05	9·04	9·29	9·13	9·12	9·00	9·36	9·53
1863	9·07	9·30	9·11	9·23	9·40	9·22	9·55	9·77
1864	8·84	9·09	9·24	9·51	9·39	9·49	9·46	9·49
1865	9·28	9·13	9·41	9·49	9·17	9·34	9·34	9·37
1866	9·27	9·07	9·36	9·34	9·35	9·28	9·43	9·60
1867	9·02	9·53	9·07	9·34	9·47	9·35	9·52	9·70
1868	9·06	9·26	9·17	9·59	9·35	9·15	9·23	9·40
1869	9·38	9·27	9·76	9·37	9·23	9·12	9·05	9·15
1870	9·07	9·52	9·37	9·21	9·19	9·09	9·19	9·55
1871	8·51	8·86	8·89	9·20	9·17	9·18	9·25	9·44
1872	8·66	8·92	9·14	9·19	9·15	9·17	9·01	9·02
1873	9·04	8·88	9·52	9·24	9·05	8·83	8·54	9·10
1874	8·82	8·88	9·12	9·29	9·12	8·83	8·96	9·37
1875	8·55	8·99	8·55	9·00*	8·85*	8·77*	8·88	9·18
1876	8·77	9·01	8·67	8·93	8·79	8·79	8·63	8·92
1877	9·04	8·93	9·51	9·11	8·73	8·63	8·94	8·78
1878	8·85	9·09	9·26	9·02	8·84	8·74	9·21	9·75
1879	8·57	9·35	8·93	9·08	8·99	8·97	9·05	9·29
1880	9·10	9·34	9·51	9·34	9·17	9·16	8·96	9·02
1881	9·45	9·11	9·62	9·32	9·02	8·13	9·24	9·44
1882	9·08	9·36	9·23	9·37	9·21	9·25	9·48	10·16
1883	9·08	9·46	9·23	9·46	9·41	9·54	9·54	9·68
1884	9·47	9·56	9·86	9·60	9·46	9·44	9·39	9·31
1885	9·74	9·49	9·90	9·60	9·36	9·30	9·45	9·67
1886	9·26	9·40	9·39	9·48	9·45	9·37	9·57	9·97
1887	9·09	9·55	9·20	9·34	9·16	9·48	9·38	9·46
1888	9·39	9·55	9·81	9·61	9·33	9·16	9·09	9·10
1889	9·38	9·32	9·62	10·03	9·28	9·14	9·19	9·55
1890	8·94	9·33	8·93	9·13	9·22	9·10	9·16	9·52
1891	8·84	9·09	9·27	9·09	8·98	9·01	8·87	9·01
1892	8·88	8·79	9·50	9·26	8·90	8·74	8·85	8·92
1893	8·81	8·90	9·29	9·14	8·90	8·56	8·88	9·17
1894	8·62	9·09	8·66	8·94	8·77	8·68	8·89	9·28
1895	8·73	8·96	9·07	8·93	8·80	8·85	8·88	8·98
1896	8·92	8·99	9·51	9·15	8·73	8·77	8·69	8·86
1897	8·91	9·05	9·28	9·09	8·75	8·67	8·95	9·44
1898	8·81	9·07	8·67	8·99	8·85	9·02	9·01	9·41
1899	9·05	9·14	9·36	9·12	9·12	9·20	9·10	9·18
1900	9·15	8·80	9·76	9·37	9·24	8·92	9·14	9·31
1901	9·05	9·47	9·30	9·24	9·12	9·15	9·17	9·55
1902	9·34	9·42	9·13	9·18	9·01	9·36	9·32	9·45
1903	10·07	9·22	9·42	9·47	9·44	9·54	9·52	9·32
1904	9·20	9·32	9·75	9·64	9·53	9·34	9·32	9·44
1905	9·04	9·21	9·70	9·64	9·52	9·43	9·20	9·59
1906	9·22	9·06	9·41	9·37	9·31	9·12	9·20	9·40

and Mean Low Water. Aberdeen, 1862–1913.

Sept.	Oct.	Nov.	Dec.	Mean	Difference from Mean of Long Period	Do. smoothed in 3's	Do. smoothed in 19's
9·57	8·99	9·10	8·84	9·17	·02	..	..
9·50	9·33	8·83	8·81	9·35	·20	·11	..
9·42	9·26	8·97	9·00	9·26	·11	·15	..
9·50	9·36	9·10	8·80	9·28	·13	·13	..
9·62	9·42	9·11	8·80	9·30	·15	·14	..
9·56	9·32	8·75	8·74	9·28	·13	·14	..
9·57	9·59	8·96	8·95	9·28	·13	·13	..
9·36	9·36	9·21	9·03	9·27	·12	·08	..
9·47	8·98	8·75	8·17	9·13	–·02	–·01	..
9·43	9·22	8·71	8·59	9·03	·12	–·09	–·024
9·24	9·18	8·92	8·73	9·03	–·12	–·13	–·024
9·31	9·10	8·78	8·51	9·00	–·15	–·17	–·024
9·40	8·90	8·36	7·91	8·92	–·23	–·22	–·015
9·24	9·18	8·72	8·73	8·88	–·27	–·27	–·003
9·11	9·04	8·66	8·50	8·85	–·30	–·25	·011
9·23	9·05	8·93	8·61	8·98	–·17	–·17	·022
9·54	9·14	8·89	8·93	9·11	–·04	–·10	·027
9·46	9·35	8·99	8·81	9·06	–·09	–·02	·032
9·34	9·31	9·11	9·15	9·21	·06	·00	·046
9·44	9·11	9·34	8·95	9·18	·03	·10	·056
9·73	9·47	9·12	8·81	9·35	·20	·17	·054
9·72	9·53	9·27	9·22	9·43	·28	·28	·053
9·51	9·59	9·49	9·50	9·51	·36	·35	·054
9·68	9·51	9·48	9·33	9·55	·40	·37	·056
9·79	9·67	9·35	9·19	9·49	·34	·32	·060
9·63	9·73	9·41	9·19	9·38	·23	·26	·056
9·39	9·35	9·27	9·36	9·36	·21	·23	·052
9·57	9·51	9·26	9·03	9·41	·26	·18	·051
9·95	9·53	8·95	8·76	9 21	·06	·06	·047
9·07	9·19	8·91	8·70	9·00	–·15	–·09	·048
9·07	8·94	9·02	8·91	8·98	–·17	–·18	·046
9·25	9·03	8·81	8·57	8·94	–·21	–·21	·038
9·34	9·34	8·78	8·61	8·91	–·24	–·23	·033
9·08	9·07	8·92	8·71	8·92	–·23	–·23	·025
8·88	8·76	8·94	8·86	8·92	–·23	–·19	·023
9·49	9·13	8·80	8·79	9·03	–·12	–·15	·016
9·47	9·29	8·97	8·87	9·04	–·11	–·08	·005
9·31	9·07	9·00	8·83	9·13	–·02	–·08	–·014
9·41	9·14	9·17	9·01	9·20	·05	·06	–·025
9·62	9·62	9·31	9·18	9·31	·16	·12	–·032
9·57	9·49	9·16	8·99	9·29	·14	·18	–·041
9·38	9·07	9·28	9·13	9·40	·25	·22	–·045
9·46	9·39	9·28	9·26	9·41	·26	·27	–·052
9·67	9·73	9·42	9·18	9·44	·29	·22	..
9·47	9·44	9·15	8·99	9·26	·11	·13	..

TABLE VII.—Range of Tide, or interval between Mean High

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
1907	9·03	9·05	9·30	9·42	9·37	9·18	9·29	9·10
1908	8·89	8·69	9·33	9·33	9·15	8·88	8·87	9·13
1909	8·79	9·23	8·88	9·04	8·82	8·73	8·82	8·24
1910	8·56	8·81	8·88	8·85	8·76	8·88	8·91	8·96
1911	8·59	8·58	9·21	9·02	9·04	8·82	8·93	8·90
1912	8·61	8·79	9·02	9·16	8·91	8·56	8·72	9·11
1913	8·61	8·96	8·48	8·84	8·61	8·60	8·54	8·94
Mean	9·01	9·14	9·25	9·27	9·12	9·04	9·12	9·34

TABLE VIII.—Milford Haven Tide Gauge. Mean Monthly Sea Level, in feet, above Ordnance Datum.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1886	12·14	11·77	12·09	12·06	12·12	12·02	12·25	12·45	12·20	12·45	12·34	12·54	12·21
1887	12·17	11·75	11·77	11·65	11·66	11·80	12·05	12·09	12·01	11·90	12·52	12·22	11·97
1888	11·84	11·46	12·03	11·78	11·84	11·98	12·25	12·18	11·83	12·06	12·62	12·67	12·05
1889	11·62	11·61	11·80	11·90	12·20	11·88	12·10	12·13	11·80	12·40	11·92	12·02	12·00
1890	12·47	11·70	11·87	11·97	12·26	11·96	11·99	12·15	12·05	11·89	12·16	12·04	12·04
1891	12·05	11·42	..	11·96	12·02	12·05	12·13	12·31	12·31	12·80	12·57	12·62	12·17
1892	12·22	12·23	12·04	11·84	12·12	12·12	11·92	12·20	11·97	12·37	12·50	12·20	12·15
Mean	12·07	11·71	11·93	11·88	12·03	11·97	12·09	12·21	12·02	12·26	12·38	12·34	12·08

and Mean Low Water. Aberdeen, 1862–1913—*continued.*

Sept.	Oct.	Nov.	Dec.	Mean	Difference from Mean of Long Period	Do. smoothed in 3's	Do. smoothed in 19's
9·10	9·00	8·96	8·92	9·14	–·01	·00	..
9·17	9·07	8·92	8·84	9·05	–·10	–·08	..
8 41	8·50	8·96	8·75	9·01	–·14	–·18	..
9·14	9·08	8·90	8·54	8·86	–·29	–·26	..
8·90	8·52	8·68	8·55	8·81	–·34	–·30	..
9·11	9·05	8·67	8·73	8·87	–·28	–·33	..
9·26	9·27	8·64	8·54	8·78	–·37	..	..
9·40	9·25	9·01	8·86	9·15	..	..	..

TABLE IX.—Mean Monthly Values of Mean Sea Level at German and Danish Ports, 1900–1909. (Differences from Mean of the whole period, in cm.). From Brehmer, *Ann. d. Hydrographie*, 1913.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Bremerhaven	6·6	– 0·1	– 9·4	– 6·5	– 7·8	– 3·6	3·8	9·5	– 1·7	5·2	2·9	0·9
Esbjerg	11·9	2·0	–10·9	–11·4	–12·5	– 8·9	–1·7	7·8	– 2·3	10·4	5·6	10·8
Hirstal	5·3	– 0·7	–11·7	–11·2	–10·0	– 5·9	4·8	10·5	– 1·2	8·5	4·1	7·1
Frederikshaven	4·6	– 2·7	–10·6	– 9·6	–10·0	– 6·8	4·7	9·8	0·7	6·5	5·9	6·4
Aarhuus	2·5	– 2·8	– 8·5	– 7·6	– 9·0	– 4·0	2·9	7·1	2·3	6·4	6·2	4·7
Fredericia	– 1·1	– 2·0	– 6·8	– 6·9	– 6·5	– 3·0	2·4	6·1	4·5	4·7	3·6	4·7
Slipshaven	0·3	– 1·3	7·7	– 7·6	3·5	– 2·7	4·1	8·2	4·9	3·4	3·0	3·0
Korsör	– 1·4	– 0·9	– 7·2	– 8·2	– 6·5	– 2·5	4·2	8·2	6·3	3·1	1 5	3·7
Hornboek	2·8	– 2·4	–12·3	–10·6	– 8·8	– 1·8	7·5	13·1	4·2	3·7	2·9	1·7
Copenhagen	0·8	– 1·0	–10·3	– 8·4	– 8·3	– 2·7	6·3	11·7	5·4	1·4	1·6	3·3
Gjedser	–6·8	1·6	– 6·0	– 7·4	– 4·6	– 1·4	5·8	9·6	9·9	1·0	– 4·1	2·6
Travemünde	– 7·4	0·9	– 5·1	– 5·2	– 5·2	0·0	5·8	7·3	9·4	0·1	– 2·5	1·4
Swinemünde	– 5·6	3·1	– 7·0	– 8·5	– 5·6	– 2·1	7·7	11·6	8·3	– 2·2	– 2·9	2·3
Memel	2·3	5·5	–10·8	– 5·1	–10·5	– 8·2	4·5	14·7	7·1	– 2·5	– 1·6	4·8
Mean	1·1	– 0·1	– 8·9	– 8·2	– 7·3	– 3·8	4·5	9·7	4·1	3·6	1·9	4·1
Mean in feet	·04	·00	–·29	–·27	–·24	–·12	·15	·32	·13	·12	·06	·13